This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

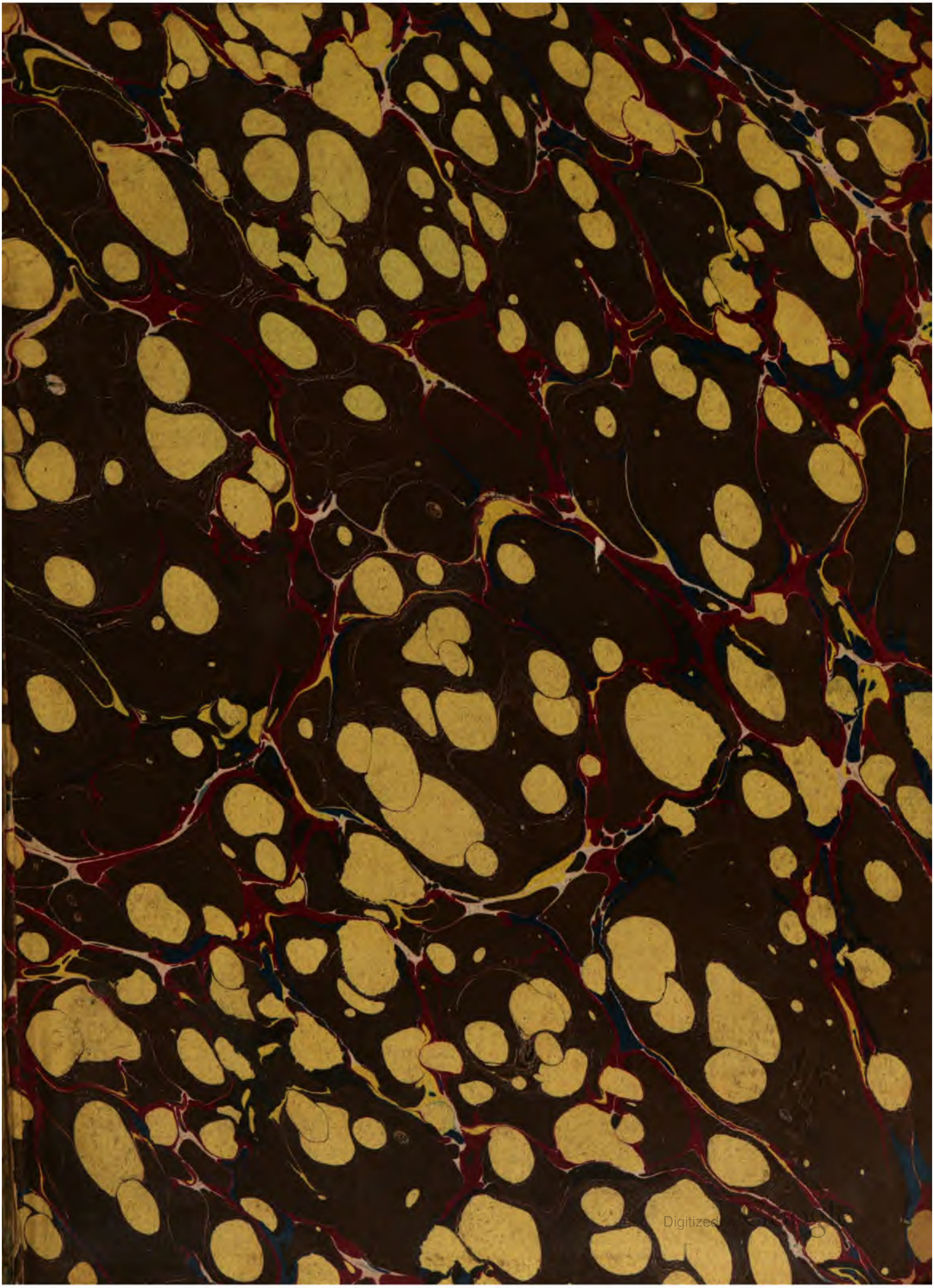
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Library
of the
University of Wisconsin
PRESENTED BY
Mrs. E. S. Koelker



DEDICATED, BY PERMISSION, TO HER MAJESTY.

1/2 Russia

ARTS AND SCIENCES

OR

Fourth Division of "The English Cyclopædia,"

CONDUCTED BY

CHARLES KNIGHT.

VOLUME III.

LONDON:
BRADBURY, EVANS, & CO., 11, BOUVERIE ST., FLEET ST., E.C.
SCRIBNER, WELFORD, & CO., 654, BROADWAY, NEW YORK.
1867.

209413
MAR -7 1917

AE
·EN4
4
3

THE

ENGLISH CYCLOPÆDIA.

ARTS AND SCIENCES.

COIN : metal stamped for currency, or in commemoration of some event, in which latter case the coin are frequently distinguished as medals. With the ancients, however, the coins used for currency had occasionally this property of the modern medal. [Medal.] The word coin is derived by some from the Greek *κόινος*, *common;* by others from the Latin, cuneus, *a wedge;* the first currency of metal, in all probability, being in the form of wedges, or ingots. Commerce, in the earliest periods, was carried on by the mere exchange of articles, and it is remarkable that throughout the early part of Scripture, as well as through the poems of Homer, not a single passage occurs from which we can infer either the use or the existence of stamped money. Metals, however, being close and compact in form, universal as to use, and admitting of division into larger or lesser parts, soon became the representatives of value, though at what exact period remains in doubt. Herodotus, i. 94, speaking of the Lydians, expressly says they were the first people on record who coined gold and silver into money. The Parian Chronicle, however, ascribes the origin of coined money to the Æginetans, under Pheidon, king of Argos, 895 years before Christ. Ælian, in his 'Various History,' corroborates this statement as far as the Æginetans are mentioned: and our best numismatic antiquaries agree in considering the coins of Ægina, from their archaic form and appearance, as the most ancient known. They are of silver, and bear on the upper side the figure of a turtle, and on the under an indented mark, as if the metal, at the time of striking, had been fixed upon a puncheon, and from the weight of the blow had received a deep cleft. In later coins of Ægina, the turtle has been changed to a tortoise, and the fissure on the other side converted into a device. The coins of Lydia probably come next in point of antiquity, and then the early Darics of the Persian kings, which occur both in gold and silver, and bear a strong resemblance to the coins of Ægina in the mode of striking: these, if they are to be referred to Darius the First, must have been coined between B.C. 522 and 486. The richer the metal, the smaller and more portable was the quantity required for the coin. There are coins in gold of the early kings of Persia, similar in type to the silver Darics, and of very minute size.

Gold Daric.

The study of coins is not to be considered as the province of the antiquary alone. Coins are among the most certain evidences of history. In the later part of the Greek series they illustrate the chronology of reigns. In the Roman series they fix the dates and succession of events. Gibbon observes that if all our historians were lost, medals, inscriptions, and other monuments, would be sufficient to record the travels of Hadrian. The reign of Probus might be written from his coins. In illustrating the history and chronology of sculpture and ancient marbles, coins enable the scholar and the artist not only to discern those peculiarities which characterise style, as it relates to different ages and schools, but to ascribe busts and statues to the persons whom they represent. The personation of the different provinces, too, forms another point of interest upon the Roman coins. Coins are frequently essential to the illustration of obscure passages in ancient writers; and preserve delineations of some of the most beautiful edifices of antiquity not existing now even in their ruins. Addison, in his 'Dialogue on the Usefulness of Ancient medals,' has long convinced the world of the connexion of this science with poetry. As a branch of the fine arts, it may be sufficient to say that some of the medals of Sicily belong to a period when sculpture had attained its highest perfection. We would particularly refer to the coins of Syracuse. In every quality of art, too, the Roman coins, to a certain period yield to the Greek alone. From Augustus to Hadrian the Roman mint was the seat of genius: and coins of admirable execution are found even down to the time of Posthumus.

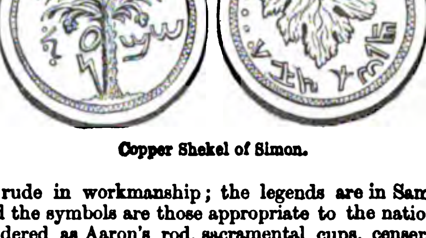
The generality of numismatic writers divide coins into Ancient and Modern;—the Ancient, into the great divisions of Greek, Roman, and Barbarian.

The *Greek* they divide into cities and kings. Of the first they can make no chronological arrangement: it is alphabetical, under the different countries. The kings commence with the age of Alexander the Great, and belong to the four kingdoms into which his empire was divided, besides the kingdom of Epirus. This series, in a chronological point of view, closes with the extinction of the dynasty of the Lagidæ in the Augustan age. The coins of the Greek cities were impressed either with appropriate symbols or the heads of deities. The coins of the monarchs bore the heads of the respective princes. Pinkerton observes that the first copper coins of Greece known are those of Gelon king of Syracuse, about 490 years before our æra. These were called Chalci, pieces of brass; others, of a more diminutive size, were called Lepta, or Kerma, as being change for the poor. He considers there is no proof of the coinage of gold in Greece before Philip of Macedon. Athens had no gold money at the beginning of the Peloponnesian war.

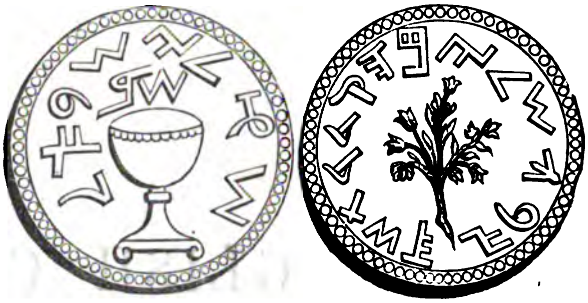
The *Roman* coins are divided into consular, imperial, and medallions. The subdivisions of the consular are into Roman ases and coins of the families. Of the imperial there are two subdivisions, Roman and Grecian; the latter being again subdivided into those of provinces, colonies, and municipia. The medallions are likewise divided into Roman and Grecian. The earliest coinage of Rome was of copper, and took place in the reign of Servius Tullius, probably about five centuries before Christ. The Romans are supposed to have borrowed the art from their neighbours, the Etruscans. Of the as, its divisions and its compounds, we have already spoken in a former article. [As.] On some of the later Roman, as well as on what were called the Italian ases and their parts, the practice became prevalent of placing the names of many of the principal families of Rome upon the fields of the coins. These form the division which are called family coins. The silver coinage of Rome was introduced in the year 266 B.C., when the denarius was so termed from its being equivalent to ten ases. Pliny informs us ('Nat. Hist.' xxxiii. 13, edit. Hard. ii. 612) that the coinage of gold was introduced sixty-two years after that of silver. The largest piece of gold was called aureus. [Aureus.] The imperial coins of Rome form the most complete and most interesting series of any extant.

Those of copper being found of different sizes, are distinguished into first, second, and third brass; in historical importance as well as for the devices, the largest series is to be preferred. The largest imperial brass coin was the sestertius, and from the Augustan age went by the name of nummus, or æreus. It was worth twopence English. All the large brass coins are of yellow metal; the middle brass, yellow and red; the small, mostly red. No sensible dimunition of the sestertius took place till the reign of Alexander Severus, when it lost upwards of a sixth of its weight, and continued to diminish till the reign of Gallienus, when it totally vanished. In this reign the chief copper coins in use were the small brass, or asaria, which, according to the writers of the Lower Empire, were at last numbered at sixty to the silver denarius. Under Valerian and Gallienus, copper washed with silver appeared. In the reign of Diocletian, a coin denominated the follis supplied the place of the sestertius; but the denarii ærei continued quite common down to Constantine I. He introduced a new coinage, and then the follis had its changes and its subdivisions; but its appellation adhered to what had now become the largest brass coin of the Roman empire, to the very latest notices which we have of the Byzantine money. From the time of Augustus to that of Gallienus, the imperial or silver denarius contained sixteen asaria. Under Caracalla a larger denarius was struck, which had a half more or twenty-four asaria, and was called argenteus: the common denarius of silver being then termed minutus. Under Gallienus, however, the minutus ceased, and the argentius and denarius then became only different names for the Roman silver coin, which at that time contained no less than sixty asaria. Constantine I. introduced the milliarensis, worth somewhere about a shilling of our money: but the argentei, or denarii, were struck as late as the reign of Heraclius. Aurei and semi-aurei were the sole pieces in gold for near three centuries. Till Sulla's time the aureus continued at thirty silver denarii. In the reign of Claudius, and afterwards, it went for twenty-five silver denarii. Under Philip, aurei of two or three sizes first appear, of a rude fabric; one class of which were called trientes. The weight originally given to the aureus was 120 grains; it afterwards fluctuated to between 80 and 90 grains, and was sometimes even of less weight. Constantine I. accommodated the aureus to his new coinage, and gave it the name of solidus, of six in the ounce of gold. The solidus passed for fourteen milliarenses. It went for rather more than twelve shillings of our money, and continued of the same standard to the very close of the Byzantine empire. The medallions were struck both at Rome and in the provinces, whence the division of this class into Roman and Grecian. The term is applied to all those productions of the Roman mint which exceeded the coins ordinarily current in size, whether in gold, silver, or brass. Medallions, says Pinkerton, from the time of Julius to that of Hadrian are very uncommmon and of vast price: from Hadrian to the close of the Western Empire they are less rare. The types of the Roman medallions are often repeated upon common coin. Those struck in the Grecian territories are the most numerous, and are distinguished from the Roman by their thinness and inferiority of workmanship. Many Roman medallions have S. C. upon them, as being struck by the senate; other have not, as being struck by order of the emperor. The Roman medals called Contorniati, it is the opinion of our first medallists, were no more than tickets of admission for different places at the public games.

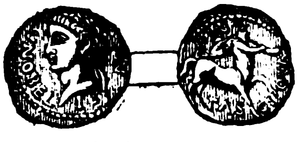
The third class of ancient coins, denominated *Barbarian*, consists of those of Lydia, Persia, Judæa, Phœnicia, Numidia and Mauritania, Carthage, Spain, Gaul, and Britain. The coins of Lydia and Persia have been already slightly noticed. The Darics, from their present extreme scarcity, are supposed to have been melted down for his own coinage by Alexander the Great, upon his conquest of Persia. Pinkerton asserts that all the real Darics were of gold, and that the silver coins with the archer (the same type) are later. Nevertheless many of the silver Darics are equally if not more archaic in appearance. Of Persian coins there is a second series, that of the Sassanidæ, beginning about A.D. 210, when Artaxerxes overturned the Parthian monarchy; they extend to the year 636, when Persia was conquered by the Arabian caliphs. The Hebrew coins were struck under the dominion of the family of the Maccabees, and chiefly in the time of Simon the high-priest, about the year 150 B.C. They are nearly all of copper, and extremely rude in workmanship; the legends are in Samaritan characters, and the symbols are those appropriate to the nation, such as a sprig, considered as Aaron's rod, sacramental cups, censers, &c. The Hebrew shekel, as it is called, is of silver, about the value of the Greek tetradrachm [SHEKEL]; and there were half and quarter shekels. Hebrew coins pretending to an earlier date than the Maccabees are spurious. The Phœnician coins are in no instance considered older than the time of Alexander the Great, and are chiefly referred to the cities of Tyre and Sidon. The Numidian coins are those of Juba I. and II. The Punic and Carthaginian coins are believed to have been struck by Greek artists. Those of Spain agree in character with the coins of the different nations by whom the several colonies of that country were planted, Phœnicians, Greeks, and Carthaginians; and many of them are inscribed with Phœnician, Greek, and Roman legends: a few others are met with, distinguished by what are called Celtiberian characters, not unlike the letters of the Runic and Etruscan alphabets. Of the coins of Gaul, the most ancient have no legends at all; they have very rude devices, and many of them are in base gold; after the Gauls had intercourse with the Romans, some of their coins bear inscriptions which look like Latin, mostly in single words, and not of easy interpretation; they are not unlike many of those which are called early British. Cæsar describes the Britons as a people just emerging from barbarism, and no further acquainted with commerce than to have discovered that it could not be conducted by simple barter alone. His account implies, that however they might have known its use, the Britons had not proceeded so far as actually to coin money; although they had a substitute for it in pieces of brass, or iron rings, or plates regulated by weight. He says, "Utuntur aut ære, aut annulis ferreis, ad certum pondus examinatis, pro nummo." ('Bell. Gall.' v. 12.) The passage, however is corrupt; for *annulis* some manuscripts read *taleis*, and others *laminis*. Coins however are found in this country which are usually attributed to the very early British kings, in gold, silver, and the inferior metals; ruder in fabric than they would have been had the Britons learned the art of coining them from the Romans. They are without legends, and many of them, like the early Gaulish coins already mentioned, have unintelligible devices; they seem to justify our antiquaries in thinking that Cæsar had not sufficient information to make his testimony quite conclusive. The use of a better sort of money was unquestionably taught the Britons by the Romans very soon after Cæsar's second invasion, when the types improved, and when no one who examines them carefully will doubt that Roman artists were employed upon the dies. The earliest coin which can, with the least appearance of probability, be attributed to any particular British monarch, bears upon it the letters SEGO, possibly for Segonax, one of the four Kentish monarchs who attacked Cæsar's camp at the time of the invasion we have just mentioned; it has also the word TASCIO upon it, which is seen upon numerous other coins which are undeniably British. Cunobelin was a later monarch of Britain, whose name is considered to be abbreviated upon the coins which have CVN, CVNO, and CVNOBELI upon them, together with the words CAMV and CAMVL, the leading letters of Camulodunum, his capital city, supposed to be either Colchester or Maldon in Essex. VER, as well as VERLAMIO at length, for Verulam, occur upon other coins of the same period. One has BODVO, which may or may not be a coin of Bonduca or Boadicea, queen of the Iceni. It is probable that the British coinage closed with the money of Cunobelin; for in a very few years after his decease the second subjection of Britain took place under Claudius, and was so complete and severe, that the country became rather a Roman than a British island. Gildas ('De Excidio Britanniæ,' c. v.) expressly speaks of a Roman edict which ordained that from that time all money current among the Britons should bear the imperial stamp. That this prohibition was followed up by the establishment of Roman mints in Britain is highly probable; and certain initial letters, as P. LON. for *pecunia Londini*, &c., are brought forward as evidence of the fact; but most of these initials are equally



Copper Shekel of Simon.



Shekel of Silver.



Coin of Cunobelin.

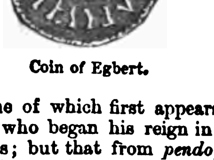
applicable to other places in the Roman empire where mints were established, and therefore do not afford a proof quite so conclusive as is wanted. We give a representation of one found in London. The coins of Carausius and Allectus, the seat of whose empire was in Britain, have a strong claim to be considered as the production of British mints. Those who wish to see under one view the 'Coins of the Romans relating to Britain,' will find the fullest information in a little volume published under that title by Mr. John Yonge Akerman, 12mo., London, 1844; much information will also be found respecting the Roman coins found in various parts of London, in Mr. Roach Smith's 'Illustrations of Roman London,' 4to, 1859.

Coin, with seated figure of Britannia.

Modern Coins are those which have been struck since the fall of the Western Empire; but it is impossible, in the space to which the present article is necessarily confined, to enter into minute details respecting the series of coins in each country. We shall be brief in our notices of the greater part, that we may devote a larger space to the coins of England.

The series of the coins of Italy under the Ostrogoths began soon after the year 480 of the Christian era. The French series commences with Clovis, A.D. 490. That of Spain with Liuva, Prince of the Visigoths, soon after the middle of the 6th century, or about A.D. 567. The states of Germany appear to have struck money very shortly after the age of Charlemagne; as well as the independent Lombard cities, and the Neapolitans. The Papal series of money begins with Pope Hadrian I., A.D. 772. Denmark has coins of an early date, but few of them are intelligible before the time of Canute; contemporary with whose date are the coins of the petty kings of Ireland. In Sweden coinage is said to have begun under Biorno, A.D. 818; and in Norway with Olave or Olaf, A.D. 1066. The Russian coinage is of a later date than the other coinages of Europe. Of Scotland pennies exist ascribed to Alexander I., A.D. 1107: those of William the Lion, A.D. 1165, are numerous. Pennies were the earliest coins in most of the European kingdoms, and a prevailing device upon them was a cross.

The *Coins of England* form the most complete modern series extant. At what time the circulation of the Roman money ceased, we are ignorant: but Sceattæ (from the Anglo-Saxon ꞅceat, shot, money) are known of the early kings of Kent, some of which must have been struck within the 6th century; and there are others so similar to them in type as to justify their appropriation to the same people, but which from their symbols were evidently coined before their conversion to Christianity. They are too rude generally to admit of description, are of silver, and found of different weights, from seven grains and a half troy to twenty and upwards: their most common weight is from fifteen to nineteen grains. Several plates of these coins are engraved in Ruding; they appear to have been current chiefly from the year 500 to 700. A sceatta of Ethelbert I. of Kent is the earliest Saxon coin which can be appropriated: he reigned from A.D. 561 to 616. Sceattæ also are the only coins which have hitherto been discovered of Egbert, king of Kent, who reigned from 665 to 674. In point of antiquity the penny succeeds; the name of which first appears in the laws of Ina, king of the West Saxons, who began his reign in 688. The word has had numerous etymologies; but that from *pendo*, to weigh, seems the most reasonable: it was then, as it still is, the 240th part of the nummary pound. The half of the penny, called helꝼlinᵹe or halꝼpeniᵹe, and the fourth part or ꝼeoꞃðunᵹ, farthing, are mentioned in the Saxon gospels; and a Saxon halfpenny of Edward the Elder is said to exist in the Bodleian collection at Oxford: but we know little more of the earliest divisions of the penny. The coin ascribed as a penny to Ethelbert II. king of Kent, between 749 and 760, with Romulus and Remus on the reverse, is beyond doubt a forgery. As to the rest of the kingdoms of the Heptarchy, no coins have yet been discovered of the South Saxon monarchs. Of the West Saxon kings, we have coins of Athelheard, A.D. 726; and of Beorhtric, who came to the throne in 784. Mercia seems to have been the most wealthy kingdom, and has a large series. It begins with Eadvald, who ascended the throne in 716, followed by Offa (whose queen Cenethreth or Quindred also enjoyed the privilege of coining), Egbert, Coenvulf, Ciolvulf I., Beornwulf, Ludican, Wiglaf, Berhtulf, Burgred, and Ciolvulf II., with whose short reign the kingdom expired. The coins of the East Angles begin with Beonna, about the year 690; but in consequence of the temporary annexation of the kingdom to that of Mercia, we have but few coins of succeeding monarchs: those only of Æthelweard, 760, Edmund the Martyr, 855, and Ethelstan, 860, are known. The kingdom of Northumberland has this remarkable peculiarity belonging to its coinage, that from its mints issued, as far as is yet discovered, the only brass coins which were struck by the Anglo-Saxons. The earliest specimen hitherto known is of the reign of Egfrith, who ascended the throne in 670: it differs from the stycas of succeeding monarchs in the omission of the moneyer's name on the reverse. Of sixteen succeeding monarchs (whose reigns occupy more than a hundred and thirty years), no coins have as yet occurred. The first that appears was struck by Eanred, who began to reign in the year 808. One silver penny of Eanred is known. His stycas are of various rude types, without any representation of the monarch, but with a legend similar to that on his silver coin, excepting that the moneyer's name stands on the reverse, without any addition. Other stycas occur of Ethelred his son 840, of Redulf, and of Osbert, whose reign began in 849. After his reign stycas seem to have fallen into disuse, at least none of a later period have yet been found. Stycas were also struck in the Saxon times by the archbishops of York: Ruding has engraved those of the archbishops Eanbald II., Vigmund, and Wulphere. One coin of Regnald, who was expelled the kingdom of Northumberland in 944, is known; and one of Anlaf, which has upon its reverse the Danish raven: these are pennies. Pennies also are known of Eric. At the beginning of the 9th century, Ecgbeorht or Egbert ascended the throne of the West Saxon kingdom; and in the course of his long reign brought under his dominion nearly the whole of the Heptarchic states; he is therefore commonly considered as the first sole monarch of England, notwithstanding those states were not completely united in one sovereignty until the reign of Edgar. On his coins he is usually styled ECGBEORHT REX, and sometimes the word SAXONVM is added in a monogram within the inner circle of the obverse: some of his coins have a rude representation of his head, and some are without it. From Egbert's time, with very few exceptions, the series of English pennies is complete; indeed for many hundred years the penny was the chief coin in circulation. Of the Saxon pennies those of Alfred bear a considerable price; on some he is called AELBRED REX, on others ÆLFRED. Edward the Elder has Saxon buildings on the reverses of several of his coins; and on one of Athelstan's is a building intended for York Cathedral. The coins of Canute and of Edward the Confessor are among the most common of the Saxon series; those of Hardicnut are rare. English coins of Canute have frequently, and of Hardicnut in a few instances, been found in Denmark. Numerous coins of Canute and Ethelred II. have also been found in Ireland.



Coin of Egbert.

The Archbishops of Canterbury, during a part of the Anglo-Saxon period, also coined money. Pennies exist of Jaenberht, Archbishop of Canterbury from 763 to 790; of Æthilheard, who died in 803; of Vulfred, who succeeded in that year; of Ceolnoth, who died in 870; of Ethered, 871; and of Plegmund, who sat from 891 to 923. In Athelstan's laws two moneyers are allowed to the Archbishop of Canterbury, but no archiepiscopal coins of that reign are known, nor indeed any until the time of Archbishop Bourchier, a space of several hundred years. Of Harold II.'s pennies there are three distinct types; two with the head looking to the left, the third, which is of very uncommon occurrence, with the head to the right; all have the word PAX in the centre of the reverse. Of the coins of William I. and II. the best account, with engravings of all the types, will be found in the 'Archæologia,' vol. xxvi. p. 1—25. Of the types there exhibited, those which bear the strongest resemblance to the coins of the Confessor and Harold are ascribed with great probability to the first William; those which most resemble Henry I.'s coins to William II. The coins which present a sceptre on each side of the king's head are universally ascribed to the Conqueror; those with two stars to William Rufus, the same ornament occurring upon his great seal. Most of them read PILLEM, PILEMV, or PILLEMVS REX A, AN, ANGLO, or ANGLOR; the P in Pillem being in reality the Saxon V (W). Of Henry I.'s pennies the types are as various as upon those of any monarch of the English series: the reverses bear the name of the mint and moneyer. This had been the Saxon practice, and it continued till the reign of Edward I. Our historians say that Henry I. coined halfpence and farthings, but none such are known in our cabinets. Through the Norman times, and certainly in the reign of Edward the Confessor, halves and quarters of the penny, regularly and nicely cut, to go as halfpence and farthings, occur almost whenever parcels of the coins of those periods are discovered. The troubles of Stephen's reign will account for the wretched state in which the pennies of that king occur: these, with what are certainly the earliest pennies of Henry II., are among the worst of the English coins in point of mintage. The barons of this reign are reputed by our historians to have struck coins; but only two or three such are known, and those of persons related to the king. Pennies are extant ascribed to Robert earl of Gloucester, bastard son of Henry I.; to Henry bishop of Winchester, base brother of Stephen; and to Eustace, Stephen's son. They are all of great rarity, as is the coin which bears the full-length effigies of Stephen and Henry II. The coin of Robert, however, is by some ascribed to Robert duke of Normandy, the eldest son of the Conqueror. Henry II., according to Ruding, had but one type; but there seems every reason to believe that the pennies which usually go by the name of the first coinage of King Henry III. are in reality the last coinage of Henry II. at the time he reformed his money, A.D. 1180. Of Richard I. and John we have no English money; but pence, halfpence, and farthings are extant of John, all struck in Ireland. Those coins with a full face, bounded by the inner circle, have the inscription IOHANNES DOM., and were struck at the time his father made him lord of Ireland; those which give the face inclosed in a triangle, and IOHANNES REX, were coined after he ascended the throne. The farthing of this last coinage is extremely rare. Of John's coins, Dublin appears to have been the only place of mintage. Henry III.'s pennies, (if those which we have considered as the latest pennies of Henry II. really do not belong to Henry III.) have usually the numerals added to his name, HENRICVS REX III. Some of his pennies have HENRICVS REX TERCI, and a few HENRICVS REX ANG. His coinage, if we may judge from the quantity of his pennies which still remain, must have been a very extensive one. Halfpence and farthings are spoken of in a record of this reign, but none have appeared. The pennies of Edward I. II. and III. are usually thus distinguished by our antiquaries: those which give the king's name EDW. are ascribed to Edward I.; those with EDWA., EDWAR., and EDWARD, to Edward II.; those with EDWARDVS, to King Edward III. A few with EDW. are known certainly to belong to Edward I., particularly those which have a moneyer's name on the reverse, ROBERT DE HADELEIE, who is known from records to have been a moneyer in 1280. Both Henry III. and Edward I. struck pennies in Ireland, in the manner of John's later coins, representing the king's head within a triangle. Edward I. struck halfpence and farthings in his great coinage of 1279, which are not unfrequently met with in the cabinets of collectors, as well as halfpence and farthings with the Irish type, struck at Dublin and Waterford. It may be sufficient, as regards these small coins, to say that they continued in currency for several centuries. The last silver farthing is known to have been coined in the reign of Edward VI., but no specimen of it has been seen: the last silver halfpenny was struck under the Commonwealth. The penny has continued through every reign to the present. Our limits will not allow of further minute description. Among the rarest in the later part of the series may be reckoned the pennies of Edward VI., Mary, and Philip and Mary. From the reign of Edward I. to Henry VIII., we have pennies which bear the privy marks of the Bishops of Durham; from Henry IV. to Henry VIII., we have coins struck in the archiepiscopal mint at York; and others of the see of Canterbury, from Archbishop Bourchier to Archbishop Cranmer. The first English pennies were 22½ grains troy. Towards the close of Edward III. the penny weighs 18 grains, and in the reign of Edward IV. it fell to 12, after previously sinking to 15. In Edward VI.'s time, 1551, the penny was reduced to 8 grains, and after the 43rd of Eliz. to 7$\frac{23}{31}$ grains, at which weight it still continues. The penny affords the best rule for estimating the other silver coins.

According to Grafton, Henry III., in 1249, ordered groats to be stamped, but none such are mentioned in any record. There is a large piece however found occasionally in the cabinets of the curious, sometimes ascribed to Edward I., but whether his, or Edward II.'s, or Edward III.'s, is uncertain. It occurs of different weights, from 80 to 138 grains, and represents the king's head on its obverse, within a double tressure of four arches, with mullets and roses; inscribed EDWARDVS DI. GR. REX. ANGL. The reverse, besides a continuation of the king's titles in the outer circle, has CIVI. LONDONIA within an inner one. There can be little doubt that it was a trial-piece. Groats and half-groats were not introduced for currency till the 25th Edward III., and continue at present, though not for circulation. A silver fourpenny piece for circulation, of a different type from the ordinary groat, was issued for circulation by William IV., in 1836. The groat received its name from the French *gros*, a large piece. In the time of Henry VII. and Henry VIII. groats and half-groats were struck in the archiepiscopal mints of Canterbury and York. It was one of the charges against Wolsey, that he had put the cardinal's hat upon the king's money, as is seen upon his York groats and half-groats.

The testoon, or shilling, was first coined by Henry VII., in 1503. The appellation of testoon was from the *teste* or *tête*, the head of the king, upon it: that of shilling is of old but uncertain origin. Pinkerton says, that coins of that name had been struck at Hamburg in 1407. The ꞅcıllınᵹ was a denomination of money in the Saxon times.

Henry VIII. struck some patterns for a silver crown; but the first crown for currency was struck by Edward VI., with the half-crown, sixpence, and threepence. Queen Elizabeth, in 1558, coined three-halfpenny, and in 1561 three-farthing pieces. Pinkerton says they were dropped in 1582, but there is a three-halfpenny piece in the cabinets of the British Museum, bearing the date of 1599. Charles I. struck twenty-shilling and ten-shilling pieces in silver, but they were of very limited currency.

From the 43rd Elizabeth, 1601, the denominations, weight, and fineness of English silver have remained the same, with the exception of the florin of two shillings and the fourpenny piece. It is worthy of remark, that, during all his distresses, Charles I. never debased his coin.

The gold coinage of England is next to the silver in point of antiquity. The gold current with us, till the 41st Henry III., was foreign. In that year, 1257, a manuscript chronicle, in the archives of the city of London, states that the king made a penny of the finest gold, which weighed two sterlings, and willed that it should be current for twentypence. Three specimens of it only are yet known to have reached us; and two out of the three are preserved in the British Museum. They are from different dies. This coin is engraved in Snelling's 'View of the Gold Coin,' in the last edition of Folkes's 'Tables,' and in Pinkerton's 'Essay on Medals.' It is from Edward III. that the series of English gold coin really commences, for no more occurs till 1344, when that prince struck florins. The half and quarter-florin were struck at the same time. The florin was then to go for six shillings, though now it would be intrinsically worth nineteen. This coin being inconvenient, as forming no aliquot part of larger ideal denominations, seems to have been withdrawn. None have yet been found, but a few quarter-florins are preserved in cabinets, and one half-florin is known. In consequence, in the same year, the noble was published, of 6*s.* 8*d.* value, forming half a mark, then the most general ideal form of money. The obverse represents the king standing in a vessel, asserting the dominion of the sea. The noble was also attended by its half and quarter. This coin, sometimes called the rose noble, together with its divisions, continued the only gold coin, till the angels of Edward IV., 1465, stamped with the angel Michael and the dragon, and the angelets or half-angels, were substituted in their place. Henry V. is said to have diminished the noble, still making it go for its former value. Henry VI. restored it to its size and caused it to pass for 10*s.*, under the new name of ryal. The ryal of 10*s.* and the angel of 6*s.* 8*d.*, with their divisions of half and quarter, then continued the sole gold coins till, in 1485, Henry VII. issued the double ryal, or sovereign, of 20*s.*, accompanied by the double sovereign of 40*s.* Henry VIII., in 1527, added to the gold denominations the crown and half-crown, at their present value, and in the same year gave sovereigns of 22*s.* 6*d.*, ryals of 11*s.* 3*d.*, angels of 7*s.* 6*d.*, and nobles at their old value of 6*s.* 8*d.* In 1546 he struck sovereigns of the former value of 20*s.*, and half-sovereigns in proportion. Henry VIIIth's gold, like his silver coin, was in the latter part of his reign much debased. Edward VI. coined a treble sovereign; and under James I. the sovereign was called a unite. The former coins however continued, with a few variations, till Charles II. coined the guinea, so called from the Guinea gold, out of which it was first struck in 1663, when it was proclaimed to go for 20*s.*, but by tacit and universal consent never went for less than 21*s.* Charles II. likewise issued half-guineas, double guineas, and five-guinea pieces, which his successors, till George IV., continued. George I. and George III. issued quarter-guineas; and George III. pieces of seven shillings in 1797. In 1815 sovereigns and half-sovereigns, of 20*s.* and 10*s.* each, were again coined, and the guinea and half-guinea were gradually withdrawn from circulation.

With the exception of the styca, the copper coinage of England arose a thousand years later than its silver. Queen Elizabeth had a great aversion to copper money, although the necessities of her people for small change were obvious. She suffered a pattern to be struck as the PLEDGE. OF. A. HALF PENNY, and James I. and Charles I. actually issued farthing tokens also as pledges; but no authorised coinage of copper was struck till 1672, when halfpence and farthings of that metal were first made public money. In 1684 tin farthings were coined, with a stud of copper in the centre. Others, as well as halfpence of the same metal, were struck by James II., and William and Mary. In 1693 the tin was called in, and copper renewed. Pieces of a penny and twopence in copper were coined in the reign of George III. The latter did not answer their purpose, and were soon discontinued. In 1852, half-farthings were coined, chiefly for use in the colonies; and in the parliamentary session of 1859, the chancellor of the exchequer announced the intention to change the copper coinage for one of a mixed and harder metal, of which the weight of each coin would be about half its present weight. Neither the denominations nor the value were to be changed.

Our space will allow us to say less than we could wish upon the money struck in France by English princes. Of Anglo-Gallic silver coins we have deniers of Eleanor, wife of Henry II., as duchess of Aquitaine, with deniers and half-deniers of Henry II., and pennies and half-pennies of Aquitaine, and pence of Poitou and Rouen of Richard I. Of John and Henry III. we know of no Anglo-French money; but there is a lion of billon of Edward I., coined during the lifetime of his father after he had received Gascony, and a plentiful series of silver and billon coins of Edward III., of Edward the Black Prince, of Richard II., Henry IV., V., and VI. The denominations of the silver were the hardi, double hardi, groat, half-groat, penny, and half-penny. In this class also fall the Calais groats and half-groats of the sovereigns of England, from Edward III. to Henry VI., and the Tournay groats of Henry VIII. Edward III. was the first of the English princes who struck gold money in France; the denominations were guiennois, leopard, chaise, and mouton; to these Edward the Black Prince added the hardi of gold and the pavilion; and Henry V. salutes and half-salutes. Henry VI. coined salutes, angelots, and francs in gold. The equivocal specimen of silver coin, supposed to have been struck by Margaret of Burgundy for Perkin Warbeck, is usually classed with the Anglo-Gallic series. The British Museum possesses a most extensive and interesting collection of coins, those of Great Britain being the largest collection in existence, and the collections of Sicilian, Greek, and Roman coins exceedingly rich.

Gold and silver with certain alloys have formed the material for the more costly currency of all European nations, and copper for most of them in those of smaller value, but France and some few others have used a mixed metal for that purpose. Russia is the only country which has used platinum in the manufacture of coins.

In respect to numismatic writers, we can only enumerate a few of the most important upon the various series of coins. On the Greek and Roman series, the best works are Eckhel's 'Doctrina Numorum Veterum,' Rasche's 'Lexicon Universæ Rei Numariæ,' and Mionnet's 'Description des Medailles Antiques Grecques et Romaines;' the last work in 5 vols., 8vo, with 7 vols. of Supplement, Paris, 1806–35. For the Roman alone, the reader may consult A. Morel's 'Thesaurus Familiarum Romanarum,' 2 tom., fol., Amsterdam, 1734; and his 'Thesaurus Numismatum Imperatorum,' 3 tom., Amsterdam, 1752. Another, which brings the Roman series to the close of the empire, will be found in Banduri's 'Numismata Imperatorum Romanorum a Trajano Decio ad Palæologos Augustos,' 2 tom., Par., 1718, with Tanini's 'Supplement,' in 1 vol., fol., Rome, 1791. See also Mionnet's work, in 2 vols., 'De la Rareté et du Prix des Medailles Romaines,' 8vo., Paris, 1827; Mullinger's 'Considerations sur la Numismatiques de l'ancienne Italie,' 1844; and Akermann's 'Descriptive Catalogue of Rare and Unedited Roman Coins,' 2 vols., 8vo, London, 1834. Pinkerton's 'Essay on Medals,' 2 vols., 8vo, 1789, with all its errors, is valuable as a general elementary treatise. A better is Mayer's 'Einleitung in die älte Römische Numismatik,' 1842; and also Mr. B. N. Humphrey's 'History of Ancient Coins and Medals;' 'The Proceedings of the Numismatical Society,' of which the publication commenced in 1836, contain a large amount of valuable information.

On English coins, the best works are Leake's 'Historical Account of English money,' 8vo, London, 1745; Ruding's 'Annals of the Coinage of Britain;' and Mr. Humphrey's 'Coins of England,' and 'Coin Collector's Guide.' Simon has written an 'Essay towards an Historical Account of Irish Coins;' and Cardonnel his 'Numismata Scotiæ, or a Series of the Scottish Coinage.' On Anglo-Gallic coins, we have a quarto volume by Ducarel; a volume of similar size, 'A Description of the Anglo-Gallic Coins in the British Museum;' and 'Illustrations of the Anglo-French Coinage,' by Major-Gen. Ainslie, 4to, London, 1830.

On the French coinage, we have the works of Bouteroue, Le Clerc, and Millin; on the Papal coins, Floravante; Florez on those of Spain. For the coins of Germany the reader may consult Madai's 'Thaler-Cabinet,' 4 tom., Königsberg, 1765–8; Weise's 'Gulden-Cabinet,' 2 tom., Nürnberg, 1780–2; and Vossberg's 'Geschichte der Preussischen Münzen und Siegel,' 1843. For Danish coins, the 'Danske Mynter og Medailler,' 3 tom., fol., Copenh., 1791–4. For Bulgarian coins, Fraehn's work, 4to, Casan, 1816. For Hungarian coins, Schönvisner, 'Notitia Hungariæ rei numariæ,' 1801, and Szecheayi 'Catalogus numorum Hungariæ,' 1810. For Russian coins Chaudoir's 'Aperçu sur monnaies russes,' 1837. For Polish coins Bandske's 'Numismatyke Krajowa.' 1839. For Oriental coins, Marsden's 'Numismata Orientalia Illustrata,' 2 vols., 4to, London, 1823–5; Grotefend's 'Münzen der Griechischen, Parthischen, und Indo-Skythischen Könige von Bactrien;' and 'Essays on Indian Antiquities, Historic, Numismatic, and Palæographic,' by James Prinsep, edited by J. Thomas, 1858.

COINING. [MINT.]

COINING. The numerous and complicated laws upon this subject, passed from time to time during several centuries, as occasion called for penal enactments to protect the coin of the realm, were repealed by the stat. 2 Will. IV. c. 34. The making or coining of money being one of the exclusive prerogatives of the crown, the counterfeiting of the king's coin was in early periods of the history of English law considered to be an usurpation upon the royal authority, and upon that principle constituted the offence of high treason both by the common law and by various statutes. By the stat. 2 Will. IV., c. 34, s. 3, the following offences are provided for:—1. Falsely making or counterfeiting any coin resembling, or apparently intended to resemble or pass for, the king's current gold or silver coin. 2. Colouring, washing, or casing over any metal or counterfeit coin so as to pass for the genuine gold and silver coin of the realm; and filing, washing or otherwise altering silver coin so as to pass for gold, or copper coin so as to pass for silver or gold. 3. Impairing, diminishing, or lightening gold or silver coin, with intent to make it pass current. 4. To buy, sell, receive, pay or put off, any false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, or offer so to do, at or for a lower rate or value than the same by its denomination imports. 5. To import into the United Kingdom, from beyond the seas, any false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, knowing the same to be false or counterfeit. (The above offences were punishable by transportation, now penal servitude). 6. To tender, utter, or put off any false or counterfeit coin, resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, knowing the same to be false or counterfeit. 7. To tender, utter, or put off any false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, knowing the same to be false or counterfeit, and at the time of such tendering, uttering, or putting off, having in possession, besides the false or counterfeit coin so tendered, uttered, or put off, one or more piece or pieces of false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin; or 8. Either on the day of such tendering, uttering, or putting off, or within the space of ten days then next ensuing, to tender, utter, or put off, any more or other false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, knowing the same to be false or counterfeit. 9. Any person having in his custody or possession three or more pieces of false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current gold or silver coin, knowing the same to be false or counterfeit, and with intent to utter or put off the same. (The four last offences are punishable by imprisonment.) The punishment is increased for the commission of any of these offences after a previous conviction.

The provisions above abstracted relate to the protection of the gold and silver coin. The following offences relate to copper coin. 1. To falsely make or counterfeit any coin resembling, or apparently intended to resemble or pass for, any of the king's current copper coin; or, 2. Knowingly, and without lawful authority (the proof of which authority lies on the party accused), to have in his custody or possession any instrument, tool, or engine adapted and intended for the counterfeiting any of the king's current copper coin; or, 3. To buy, sell, receive, pay, or put off, or offer to buy, sell, receive, pay, or put off, any false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current copper coin, at or for a lower rate or value than the same by its denomination imports. 4. To tender, utter, or put off any false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current copper coin, knowing the same to be false or counterfeit, or having in custody or possession three or more pieces of false or counterfeit coin resembling, or apparently intended to resemble or pass for, any of the king's current copper coin, knowing the same to be false or counterfeit, and with intent to utter or put off the same.

The statute also contains various provisions against making, sending, or having in possession, any coining tools. By the 16 & 17 Vict. c. 48, the provisions of the 2 Will. IV., c. 34, were extended to the colonies, and punishment provided for importing counterfeit coin into the colonies. A practice which arose of defacing coin by stamping and bending it for advertising purposes was met by the 16 & 17 Vict. c. 102, making the offence a misdemeanour, and imposing a penalty on uttering such defaced coin. The statute also makes a tender of such coin invalid.

COIRE. The manufacture of cordage, mats, matting, coarse canvas, and sailcloth from the fibres of vegetables, has been known to the inhabitants of nearly all countries with which we have any acquaintance. So far, however, from the source from which the material is obtained being alike in all plants, it differs considerably. In flax and hemp the fibrous material is furnished by the stem, deprived of its ligneous centre or core. In the Spanish broom the fibres are furnished by the young pliant branches of a shrub; and these fibres are occasionally wrought both into cloth and into cordage. The stalks of the hop-plant, and also of the common nettle, are made to yield fibres applicable to a similar purpose; and so likewise may be those of the bean-plant and of the mallow. In other cases it is rather the bark of a tree than the stem of a young plant that yields the fibres. Such is the case with the paper-mulberry tree, the bark of which is so prepared by the natives of Tahiti as to yield fibres fitted for a kind of cloth. Such is likewise the case with the linden-tree, the bark of which, prepared in a suitable way, is used for the manufacture of mats, baskets, bags, and thatching. It is estimated that fourteen million mats are made annually in Russia from this material; that for this purpose the bark of a million trees is required; and that a traffic equal to half a million sterling is thus created. Two other examples of the same kind are furnished by the maho-tree (*Hibiscus tiliaceus*) and the *Theobroma augusta*, two East Indian plants, the stalks of which are steeped and disentangled from the fibres of the inner bark. Another class of materials for similar purposes is furnished by the leaves of certain plants. The *Phormium tenax*, or New Zealand flax, has leaves which produce such fibres. The enormous leaves of the *Agave*, or American aloe, yield fibres capable of answering a similar purpose; and so likewise do several species of the *Bromelia*.

But *Coire* differs from all these in its origin. It is the fibre of the husk of the cocoa-nut, bearing such relation to it as the downy fibres of cotton do to the seeds of the cotton-plant. The inhabitants of Ceylon make great use of it. The nut is gathered before being completely ripe; and in order to remove the husk, an iron spike or sharp piece of hard wood is fixed in the ground, and the nut is forced upon the point in such a manner as to separate the rind from the shell. One man can clear about a thousand nuts in a day by this means. The rind of the nut is soaked in water for several months, then beaten upon a stone with a piece of heavy wood, and afterwards rubbed with the hand until the intermediate substance is completely separated from the fibrous portion. The rind of forty average nuts supplies about six pounds weight of the fibre. This fibre constitutes the coire, which is then ready for use in the same way as hemp or other fibrous materials.

This material possesses great tenacity. Indeed, Dr. Roxburgh remarks, that "coire is certainly the very best material yet known for cables, on account of its great elasticity and strength." The material is very buoyant, and well suited for making ropes of large diameter. Until chain-cables were introduced, all the ships which navigated the Indian seas had cables made of this substance. The fibres are rather improved than injured by immersion in sea-water; but the smoothness and elasticity of the coire-cordage, though very advantageous to running-rigging and the light lines of a ship, render it less fitted for standing-rigging.

There has been a branch of manufacture introduced within the last few years in England, in which coire is employed rather differently than in the above-described instances; this is for the production of rugs, druggets, mats, matting, mattresses, and similar coarse goods. Dampier mentioned two or three centuries ago the production of cloth from such a material; for he says, "I have been told by Captain Knox, who wrote the 'Relation of Ceylon,' that in some places of India they make a sort of coarse cloth of this husk of the cocoa-nut, which is used for sails. Myself have seen coarse sailcloth made of such a kind of substance." Besides the actual weaving or plaiting of this material into textile fabrics of a coarse kind it is used as a stuffing for mattresses, pillows, and cushions. Dampier alluded to the use of the fibres to caulk the seams of ships; and Mr. Marshall speaks of the employment of them in India in stuffing mattresses, cushions for couches, and saddles, as a substitute for horse-hair. The availability of the material for such a purpose seems to depend upon these qualities: that the coire is very indestructible; that it does not harbour vermin, as horse-hair would in a warm climate; and that it is free from offensive smell.

The quantity of coire now imported is large, but it cannot be quite determined from the Board of Trade returns, in which it is included with "jute, and other vegetable substances of the nature of hemp."

COKE, the solid residue obtained by the destructive distillation of coal. It consists almost entirely of carbon, associated with a certain quantity, usually small, of incombustible mineral matter, which is left behind as ash when the coke is burnt.

As an article of commerce, it is produced by partial combustion in close chambers, or in heaps from which the free access of air is excluded. Being composed almost entirely of carbonaceous matter, coke is a fuel much purer and better adapted for use in smelting and various other furnaces than raw or uncoked coal; and as it is divested of those constituent parts which produce most dark-coloured smoke, it is especially preferred in cases in which it is necessary to avoid the emission of smoke, as for the furnaces of locomotive engines. The introduction of railways has occasioned a very large demand for coke for this purpose, though its use in the manufacture of iron has been diminished in some degree by the adoption of the hot-blast for furnaces, by the aid of which uncooked coal may be used in lieu of coke.

The simplest mode of coking, which is still occasionally followed, is to lay the coal in large flattened heaps, often containing 30 or 40 tons each, in the open air, covering it with ashes and earth to confine the heat, so that the mass of coal may be slowly burnt in a smothered manner, men being employed during the process to renew the covering wherever the fire may begin to burn through too fiercely. The late Dr. Ure, in describing various modes of making coke in Germany, noticed both circular and oblong coking *meilers* or mounds of this character, the former being piled round a central chimney built of loose bricks, towards which small horizontal flues are laid among the lumps of coal forming the mound; while in the latter vertical flues or chimneys are provided by the insertion, while the mounds are forming, of wooden stakes, which, when the whole pile is completed, are withdrawn, their place being filled up with readily combustible materials, to aid in igniting the mass of coal. The exterior of these meilers is covered with *slack*, or coal-dust, and clay.

The best and most economical method of making coke is in close ovens, which are built in various forms. In some large establishments these ovens are a hundred or more in number, each being a brick structure eight or ten feet high, with a flat roof in which is an opening for introducing the coal, and with another opening in front from which to remove the coke. The ovens being placed side by side in a continuous range, a railway is laid along their flat roofs by which the coal is brought close to the charging-holes, while another, running on a lower level, in front of the openings by which the coke is taken out, affords facilities for its removal. Dr. Ure gave details of various forms of coke-ovens, of which we can only notice the very excellent kind adopted by the London and North-Western (at that time the London and Birmingham) Railway Company for making coke at the Camden-Town station, for the use of their locomotive engines. Each of these ovens was, internally, of an elliptic form, measuring 12 feet by 11 in the clear, and surrounded by brick-work 3 feet thick. The internal height was about 4 feet, the floor being flat, bedded upon a thick stratum of concrete, and the roof in the form of a flat dome. In the front of each oven was an opening about 3 feet square, covered by a cast-iron door lined with fire-bricks, which slid up and down by means of chains and counter-weights. At the back of the roof was an opening, capable of being wholly or partially closed by a sliding damper communicating with a horizontal flue which conducted the smoke to a high chimney serving for the whole range of ovens. The ovens were charged through the front opening with about three tons and a half of coals, upon the top of which a little straw was thrown. The oven being very hot from its preceding charge, smoke began immediately to rise from the mass, while the straw became ignited by radiation from the dome. By the active combustion thus excited on the surface of the coal the greater part of the smoke was consumed, all that arose from the half-ignited coals having to rise through the fully-kindled coals on the surface, which were freely exposed to the access of air, both the furnace door and the flue being for a time left fully open. As the operation proceeded, the fire burned regularly downwards, and the doors and dampers were gradually closed. After a calcination of upwards of forty hours the doors and dampers were perfectly closed, by which means the mass was partially cooled, and formed itself into prismatic concretions, somewhat resembling columnar basalt; when sufficiently cooled the furnace was opened, and the mass of coke broken up with iron bars and thrown out upon the pavement to be extinguished by sprinkling water over it. When the coking is conducted in this manner a very small quantity of unconsumed gas and soot escapes, and the coals, if good, yield about 80 per cent. of compact glistening coke, weighing about 14 cwt. per chaldron. The more recent operations of the railway companies have led to the introduction of many improved processes in coke-making. In ordinary coking-ovens the loss in weight is about 25, instead of 20 per cent., but the bulk of the coal is increased about 25 per cent. by the process.

The production of coke in the manufacture of coal-gas is noticed under Gas-Lighting.

In 1854 the London and North Western Railway company requested Messrs. Woods and Marshall to institute a series of experiments, to determine whether coal could advantageously be used in substitution of, or in combination with, coke in locomotive engines. The experiments were made with Hawksbury coal, dug from a pit near Coventry; it was selected on account of the proximity of the pit to the railway, and also because the coal is hard, and possessed of other favourable qualities. The main coal could be supplied in large lumps at the Rugby depôt for 9*s*. 8*d*. per ton. Some of Mr. M'Connell's locomotives were tried, alternately with Hawksbury main coal and with the best coke. Under nearly equal circumstances in other respects, a consumption of 25 lbs. of coke was found to equal that of 35 lbs. of coal, in working effect; and 8¼ lbs. of water were evaporated by 1 lb. of coke, against 5¾ lb. by 1 lb. of coal. In trials with various engines, drawing various loads, the comparative results were nearly as above, in some cases more favourable to the coke. The result of the experiments showed that the use of coal in locomotives is quite practicable; that the engines, with coal fuel, have no difficulty in maintaining the required speed and pressure of steam; that the consumption, or rather non-production, of smoke may be very nearly attained; but that the last-named advantage depends very much on the skill and attention of the men employed, there being a necessity for a much more frequent supply, and for smaller quantities at each firing. Taking the results of one particular locomotive as an example, it was found that 1 ton of coke did about as much work as 1¼ tons of coal; but as the price of a ton of the latter was 9*s*. 8*d*., and that of the other 21*s*., the money-cost for a given amount of power produced was less in the coal to the extent of nearly 7*s*. per ton. The experimenters found, however, that the company possessed only a small number of one particular kind of engine suitable for burning coal without producing smoke; and it would become, therefore, a commercial question how far it would be worth while to build new engines for the sake of ensuring these advantages.

There has long been, and still is, a controversy among practical men, not only concerning the relative qualities of coke and coal for use in locomotives, but in furnaces generally. At Pellatt's glass-works, near Blackfriars' Bridge, coke has been found to possess better qualities than coal for heating the kilns: 18 cwt. of coke was found to produce as much heating effect as 20 cwt. of coal. It has been found that, if a little coal be mixed with a preponderant quantity of coke, the glass ingredients become refined many hours earlier, the effects are more certain, there is less injury to the melting-pots, there is much less emission of smoke, and there is less cost by 2¼ per cent. than when coal alone is used. The best coke is found to be obtainable from Newcastle coal, the next best from Wigan, a third quality from Barnsley, and a quality nearly as good as breeze from cannel coal. The sooner coke is used after making, especially if gas-coke, the better. It has been laid down by some manufacturers, that whenever a chaldron of coke is sold at a lower price than a ton of small coal, it is cheaper to use coke than coal. Many manufacturing establishments now mix coke largely with their coal, thereby greatly lessening the emission of smoke; but in the North, where coal is cheaper, and where smoke-prevention is little thought of, coke is not much used in steam-engine furnaces. Many persons object to the use of gas-coke, on account of the unpleasant smell of sulphur belonging to it; to remedy this, one of the gas companies at Liverpool is in the habit of using salt, in the ratio of 14 lbs. to every charge of coal; this is said to lessen considerably the sulphureous exhalation from the coke. From various and somewhat conflicting reports of experiments made, it would appear that the relative profitableness of coke and coal as fuel depends greatly on locality; the ratio between the prices of the two being by no means uniform. If, on the one hand, manufacturers are trying to substitute coke for coal in many fixed furnaces, railway companies, on the other, are seeking to substitute coal for coke in locomotives. The experiments require to be carried to a much greater extent, before these problems can be effectually solved.

Many patents have been obtained for peculiar methods of preparing coke; but they do not require any lengthened notice. One is for a mode of applying muriatic acid to small coal, to dissolve the carbonates of lime and magnesia, and other impurities, after which the roasting is effected. Muriatic acid being rather a costly liquid when thus employed, it is suggested to employ the refuse acid from alkali works. Another is for a mode of obtaining ammoniacal salts. The products of combustion are to be drawn off by a blower into a flue, in which is placed a refrigerator; they then pass into a condensing chamber, where they come in contact with surfaces over which a stream of dilute sulphuric acid is trickling; the ammonia is taken up, and the non-condensible gases allowed to pass off.

COLCHICINE, the active principle of the meadow saffron (*Colchicum autumnale*). It was at one time regarded as identical with veratrine. It is soluble in water, alcohol, and ether. It forms salts with the acids, which are bitter, acrid, and poisonous. In small doses it causes purging.

COLCHICUM, *Medical uses of.* In a small dose, colchicum causes an increased flow of urine, and more frequent evacuations from the intestinal canal, and occasionally augmented secretion from the skin; in larger doses, frequent evacuations from the intestines, accompanied with pain and tenesmus, and desire repeatedly to empty the bladder. Still larger doses cause increase of all these actions, with vomiting and sense of burning in the throat, insensibility and stiffness of the tongue, escape of blood into the intestinal canal, vomiting of blood, and a flow of bloody urine. Great disturbance of the nervous system is likewise observed, as in other cases of poisoning with acrid substances. The same appearances are found in the intestinal canal, if the poison be injected into the veins. Even the milk of cattle which have eaten the meadow-saffron becomes capable of causing death. (Vogt.)

In a moderate dose, colchicum seems to increase the quantity and improve the quality of all the secretions of the intestinal canal and the collatitious viscera, especially the liver; but it likewise exerts a sedative action on the heart. Chelius says that in twelve days it doubles the quantity of uric acid found in the urine, a circumstance which explains its utility in gout and rheumatism.

The diseases in which colchicum is most useful are, dropsy, when a small dose is prescribed; gout, in which larger are used; and rheumatism, in which its beneficial influence is first felt on the liver (which is almost always disordered in these diseases), and afterwards on the kidneys, from which a larger portion of uric acid is excreted, and the formation of gout-stones (urate of soda) in some degree prevented. As acid in the stomach renders the action of colchicum more violent, magnesia is usually given along with it. The acetate and acetous extract are the best forms of administration.

COLCOTHAR. [Iron, *Sesquioxide of.*]

COLD. [Catarrh; Heat.]

COLE, COLZA, a cultivated state of the *Brassica napus*, which does not form a close head, like cabbage, but has sessile heart-shaped leaves. It is cultivated for its seeds, from which an oil is expressed, which is much used for burning in lamps, and in the manufacture of leather and soap.

There are two varieties of cole, one with white flowers and another with yellow; the latter is the hardiest, and consequently most generally cultivated.

It requires a good loamy soil, well manured, to produce a good crop of cole seed. In rich land lately broken up from pasture, or fenny land newly drained, it grows luxuriantly and gives a great return. It is thought to be a great exhauster of the soil. Half a gallon of seed is drilled in rows 14 or 16 inches apart about the end of July, and left thinned out until the following year, when it is cut in June and July, yielding 20 to 30 bushels of seed, which is sold at from 8*s.* to 10*s.* a bushel. An oil is expressed from it, and the refuse, a rape cake, is made as food for sheep or cattle; being worth for that purpose more than its comparatively low price, 6*l.* per ton, when oil cake is 10*l.* to 12*l.* a ton, would indicate. In a rotation, cole is considered as a good crop to precede wheat. Like rape, which is another variety, it is sometimes sown to be fed off by cattle and sheep on land which is not so well adapted to the growth of turnips. [Rape.]

COLIC (from *κῶλον*, *colon*), *dolor colicus*, called by Sydenham and the old English writers the dry belly-ache; a disease attended with severe pain of the bowels, remitting and recurring at intervals, with constipation, and without fever. The seat of this malady is conceived to be chiefly, if not entirely, in that portion of the large intestines called the colon, and hence its name. It arises from a great variety of causes, and assumes a corresponding variety of forms, many of which have received distinct names; but pain and constipation of the bowels, with the absence of fever, are common to them all; and this concurrence of symptoms is essential to the medical notion of colic.

The pain in colic often most distinctly follows the course of the colon, while the morbid distension and contraction of the bowel (for these two morbid states alternate with each other, and attack successively different portions of the intestines) often become visible to the eye. The colon receives all that portion of the food which is not converted into chyle, together with all those portions of the pancreatic, biliary, and intestinal secretions, which do not form component parts of the chyle. Consequently it has a considerable mass of matter to carry downwards and convey out of the system. It is provided with muscular fibres, very much larger than those which belong to the small intestines. These fibres form three large bands, which are placed in a longitudinal direction along the intestine, and which produce the effect of dividing the inner surface of the colon into folds, so disposed as to form little distinct apartments called cells. In these cells the feculent matter, which should be slowly but progressively carried downwards, is sometimes collected and closely impacted, so that when at length rejected it has the form of those cells constituting hard rounded balls, termed *scybalæ*. The natural stimulus to the muscular fibres of the colon is the resinous portion of the bile [Bile, Nat. Hist. Div.], together with the non-nutrient portion of the aliment. It is easy then to conceive how a loss or diminution of the contractile power of these fibres may occasion the constipation incident to colic, attended with the retention of the feculent matter in the cells of the colon; how a suppression or an altered condition of the bile may contribute to the same effect; and how an acrid quality of the bile and of the non-nutrient portion of the aliment may produce the irritation and pain incident to colic. The colon then, both from its structure and function, it is obvious must be peculiarly predisposed to such an affection as that to which, from the frequency with which it is the subject of the malady, it has given a name. It is perhaps desirable that the term colic should be restricted to the designation of a disease of a definite character, seated in the colon; and some medical writers do so limit the use of the term, though others give it a more extended signification, and with less propriety include under it diseases which do not arise primarily in the colon, but in some neighbouring organ, the colon being only secondarily and sympathetically affected.

Colic, properly so called, is attended with severe griping pains in the bowels, which often follow very accurately the course of the colon; sometimes having their seat in one portion of it and sometimes in another. These pains remit for a time, affording intervals of ease; but they soon return with increased violence. They are often relieved by pressure, a character by which they are distinguished from pain occasioned by inflammation, the latter being always increased by pressure. The pain is usually attended with a greater or less degree of flatulence. The flatus sometimes collects to such an extent as to occasion a prodigious dilation of the bowels, greatly increasing the pain. When the digestive process is perfectly natural, it is always attended with the evolution of some portion of gas; in disordered states of digestion, the quantity of gas is often very much increased. While one portion of the intestine is thus preternaturally distended, another portion is in a state of preternatural contraction, from the irregular spasmodic action of the muscular fibres of the colon, excited by the irritating cause—whatever it may be—which produces the disease. These irregular spasmodic contractions of the colon are always present when this disease is severe, and are intensely painful. The constipation, which is so constant as to be a diagnostic character of the malady, is often long continued and obstinate, and the consequent accumulation of feculent matter is very great. To the preceding train of symptoms is very frequently superadded vomiting, which is often urgent and most distressing; and in cases of the greatest severity, the action of the whole intestinal tube above the seat of the disease is inverted, and the fæces are mixed with the matter vomited. Occasionally there is hiccough, and very often the griping pains are attended with loud rumbling noises in the interior of the intestines.

It is unnecessary in this place to enter into the details of the varieties of this malady to which physicians have assigned distinct names, since these varieties are merely modifications of the same disease produced by different causes. The preceding account will be sufficient to give to the general reader a distinct conception of the nature of the malady, and of the causes which produce it; and it is only necessary to observe respecting the treatment, that the two great principles on which the cure depends are the complete evacuation of the intestines, and the strict regulation of the diet. It is indispensable that the evacuation of the intestine of its accumulated and irritating contents should be complete, and this is best effected by an alternation of mild and unirritating aperients, with opiates. After the intestine has been fully relieved of its load, it is necessary to persist in a course of mild aperients for a considerable time; because the bowel long remains in an irritable state, and very slight causes are apt to occasion a relapse. For the same reason only the most bland and unirritating substances should be taken as food; all acid and acrid matters in the solid and all stimulating matters in the fluid aliment should be most carefully avoided.

The accidental introduction of lead into the system often produces symptoms resembling those of ordinary colic. [PAINTER'S COLIC.]

COLISEUM, OR COLOSSEUM. [AMPHITHEATRE.]

COLLATERALS. [CONSANGUINITY.]

COLLATIO, or MOSAICARUM ET ROMANARUM LEGUM COLLATIO, or LEX DEI, is a compilation, probably made in the 6th century of our era. It consists of a comparison between the Law of Moses and the Roman Law, in sixteen titles. Each title has certain legal rules at the head from the Law of Moses, headed thus, "Moses dicit;" to which are subjoined, by way of comparison, rules of Roman law taken from the five Roman jurists—Papinian, Paulus, Gaius, Ulpian, and Modestinus—and from the three compilations which preceded that of Justinian—the Gregorianus Codex, Hermogenianus Codex, and Theodosianus Codex. The value of the Collatio consists solely in the extracts which it contains from the source above mentioned. The last and best edition of the Collatio is by Blume, in the Bonn edition of the 'Corpus Juris Ante-Justinianei,' and in the separate edition of 1833, 8vo. The first edition is by P. Pithou, Paris, 1573, 4to. It is also printed in Schulting's 'Jurisprudentia Vetus ante-Justinianea,' Leyden, 1717.

COLLATION. [BENEFICE.]

COLLE'GIUM, or CONLE'GIUM, from the word *colligo*, "to collect or bring together," literally signifies any association or body of men; but a technical meaning was attached to it, namely, that of a number of persons joined in some office or employment, or living by common rules. The word Corpus was also used in the same sense (D. 50, 6, 5), and those who were members of a collegium or corpus were hence called corporati. The word Universitas was sometimes used as equivalent to Collegium or Corpus, but it had also the more general signification of "community," or "collective body of citizens." In the Roman polity collegium signified any association of persons such as the law allowed, requiring confirmation by special enactment or by a senatus consultum, or an imperial constitution, in which case it was called Collegium Legitimum. A collegium necessarily consisted of three persons at least. (Dig. 50, tit. 16, l. 85.)

In general, any association or collegium, unless it had the sanction of a senatus consultum, or of the emperor, or were established by a lex, was illegal (illicitum); and on proof of such illegality, might be dissolved by imperial letters (mandatis), constitutions, and senatus consulta; and when dissolved, the members were allowed to divide the property of the association according to their respective shares. (D. 47, 22, 3 pr.) The members of a collegium were called sodales; the terms and object of their union or association might be any that were not illegal.

A great variety of collegia (many of them like our companies) existed at Rome and in the empire, as we see by ancient writings and inscriptions, such as the Collegia Fabrorum, Pistorum, Pontificum, Fratrum Arvalium, Virorum Epulonum, Augurum, &c. Some of these, such as the colleges of Pontifices and Augurs, were of a religious character. These collegia possessed property as a corporate body; and in the time of the Emperor Hadrian, if they were collegia legitima, they could take a legacy or bequest (C. 6, 24, 8) in their corporate capacity. Collegia were allowed, as a matter of course, to have a common chest, and an actor, syndicus or attorney, to look after their rights and interests, and appear on their behalf. Plutarch ascribes the origin of colleges, as a political institution, to Numa Pompilius; and Dionysius mentions an ancient law, passed by Tarquin the Proud, for the purpose of putting down the societies and colleges which were then in existence at Rome. That the institution was often perverted to improper ends, we have proof not only in the writings of the Roman authors (see, among others, Cicero, 'Pro Sextio,' c. 15), but in the repeated enactments that were aimed at the colleges from time to time. (See Suetonius, 'Julius Cæs.,' c. 42; and 'Augustus,' c. 32.) (D. 3, 4, 1, 1.) The maxims—that what was due to a university was not due to the individual members; and that the debts of universities were not the debts of the individual members; and that even though all the members were changed, the university still existed—comprehend the essential notion of a corporation as understood by the law of England.

In England, a COLLEGE is an eleemosynary lay corporation, of the same kind as an hospital, existing as a corporate body either by prescription or by the grant of the king. But as regards Christ's Church, Oxford, that has been held to be a spiritual body, as being, not a college, but a dean and chapter. (Fisher's case, Bunbury, 209; and in Pitt *v.* James, Hobart, 122.) Trinity College, Cambridge, was expressly held to be a spiritual corporation, under the Stat. 1 & 2 Phil. & Mary. A college is not necessarily a place of learning. An hospital, also, is not necessarily a mere charitable endowment, but is sometimes a place of learning, as Christ's Hospital, London. Its particular form and constitution depend on the terms of the foundation. (Phillips *v.* Bury, 1 Lord Raymond 5; and Skinner, 447.) A college consists of a head, called by the various names of provost (præpositus), master, rector, principal or warden, and a body of fellows (socii), and of scholars also, besides various officers or servants, according to the peculiar nature of the foundation. A college is wholly subject to the laws, statutes, and ordinances which the founder makes, and to the visitor whom he appoints, and to no others. All elections, and the general management of a college, must be in conformity with such statutes or rules. If a college does not exceed its jurisdiction, the king's courts have no cognisance, and expulsion of a member is entirely within its jurisdiction, and therefore, in general, a mandamus cannot be had to restore a fellow to his fellowship (Comyn's Digest, 'Visitor,' s. 15); nay, more, where a college, as visitor, had removed an individual from a mastership in a school, not only has a mandamus been refused (Craford's case, Styles, 457), but the Court of Chancery refused to interfere by injunction (Whiston *v.* Dean and Chapter of Rochester, 18 Law Journal, Chancery, 478). If there is no special visitor appointed by the founder, the right of visitation, in default of the heirs of the founder, devolves upon the king, who exercises it by the great seal; and in such case it is to be exercised by the crown cyprès (or as near as possible) to the manner in which it was exercised by the founder and his heirs. (R. *v.* St. Catherine Coll., 4 Term Rep. 243.) When the king is founder, his successors are the visitors.

The general power of a visitor is to judge according to the statutes of a college, to expel and deprive for just reason, and to hear appeals. His precise powers are determined by the founder's statutes, and if there are any exceptions to his power, the jurisdiction in such excepted cases devolves on the king. Certain times are generally named in the statutes for visitation, but the visitor may visit whenever he is called in, it being incident to his office to hear complaints. So long as a visitor keeps within his jurisdiction his acts cannot be controlled, and there is no appeal from him, as was decided in the above-mentioned case of Phillips *v.* Bury. The visitors are not bound to any particular forms of proceeding, and, in general, want of jurisdiction is the only ground on which they are liable to prohibition. If a visitor's power is not limited or defined, he must use his best discretion. If a power to interpret the statutes is given to any person, as to the bishop of the diocese, this will constitute him and his successors visitors. The heirs of a founder cannot alter the statutes, unless such a power is expressly reserved; and it appears, that where the king is founder, his successors cannot alter statutes without the consent of the college, unless such a power is reserved. But as to the power to alter statutes, it must be observed, that in the case of the crown at least, it has not unfrequently been done, though such a power might now possibly be disputed, unless expressly reserved to the founder and his heirs by his original statutes. In Attorney-General *v.* Archbp. of York (2 Russell & Mylne, 468), Lord Brougham said, "No man can doubt what the powers of a visitor are. In practice they are perfectly uncontrolled, of removal, new appointment, variation, and alteration. They are, in truth, of a most extensive and arbitrary nature." But Lord Mansfield has expressed strong doubts whether a visitor can repeal or alter statutes without an express power given by the founder. (1 Burrows, 201.)

Whenever a visitor is appointed, the Court of Chancery never interferes with the internal management of a college; how far it exercises jurisdiction in matters pertaining to the management of the funds, on the ground that as to the funds of a college, those who possess the legal estate are in the situation of trustees, is a doubtful point. Certainly, in the case of charitable foundations, where the governors or visitors are trustees for the charity, and are found to be making a fraudulent use of their powers, the Court of Chancery can and will interfere on information (see 15 Ves. 314); and even where the founder has left directions in his will vesting the sole government and management of the charity in the visitors, the Court of Chancery will exercise control, where *such visitors are also trustees* of the charity estates. It is said, however, that such interference of Chancery with visitors, is only where both the legal estate and the receipt of the rents are vested in the visitors. (Att.-Gen. *v.* Middleton, 2 Ves. sen. 328; see Green *v.* Rutherforth, 1 Ves. sen., 473 & 475.) In colleges, when a new foundation is engrafted on an old one, it becomes part of the old one, and subject to the same visitorial authority, unless in the indenture of annexation by which the college takes the additional foundation a difference in the matter of visitation is expressly declared (R. *v.* Bishop of Ely, 1 W. Blackstone, 70); unless new statutes are given with the new foundation, in which case the college accepting the foundation will be bound in all respects by the new statutes, for they take the benefit *cum onere*. (See the cases collected in Grant on Corporations, 542, u.)

The validity of all elections in colleges must be determined by the words of the founder's statutes or rules. In the disputes that have arisen on elections, the point has generally been, whether the master's concurrence is necessary, or whether a bare majority of the electors, of which electors the master is one, is sufficient. (See, as to this, Grant on Corporations, 532, 538, 539.) In Catharine Hall, Cambridge, fellows must be elected "communi omnium consensu aut saltem ex consensu magistri et majoris partis communitatis;" and it was held by Lord Eldon, upon these words and another clause which follows, that no election was valid in which the master did not concur.

The statutes of Clare Hall, Cambridge, require "that the election of a fellow shall be by the master and the major part of the fellows present;" and here it was held, on reference to the chancellor, the Duke of Grafton (A.D. 1788), that a valid election might be made without the concurrence of the master. But this interpretation is obviously wrong, and is referred to with disapprobation in the case of Queen's College, Cambridge (5 Russell, 97), in which case the lord-chancellor, Lord Lyndhurst, in declaring his opinion with reference to the college then before him to be that the concurrent voice of the president was necessary in all elections of its fellowships, expressly rested his decision on the judgment of Lord Eldon in R. *v.* Catharine Hall, 4 T. R. With reference to the subject of election to and tenure of fellowships, two modern cases are deserving of notice as bearing upon the construction which the Court of Chancery puts upon college statutes: these are In re St. Catharine's Hall (1 McNaght. & Gord. 467), and exparte Edleston (1 De Gex, McN. & Gord. 742). The latter case is important as maintaining the principle that new statutes embodying old ones do, in the absence of any express intention to the contrary, get rid of dispensing (or remedial) statutes. Before dismissing this topic, it should be noticed, that the whole matter is now (1859) in a transition state, the statutes of the different colleges being under the revision of a committee appointed by the government for that (among other) purposes.

Colleges (13 Eliz. c. 10) could not grant leases of their land beyond twenty-one years, or three lives; and in such leases the accustomed yearly rent, or more, must be reserved, payable yearly during the term. By 18 Eliz. c. 6, in all leases made by colleges in the universities, and by the colleges of Winchester and Eton, one-third of the whole rent must be reserved in corn. By a very recent statute (21 & 22 Vict. c. 44), the subject of college leases and powers to sell and exchange has been materially affected. The Act enables the three universities of Oxford, Cambridge, and Durham, and their colleges, and the colleges of Winchester and Eton (*a*), to sell, enfranchise, and exchange lands, (*b*) to grant leases for agricultural, building, and mining purposes, and (*c*) to deal with the interests of lessees. Under the first head they are empowered to sell, enfranchise, and exchange through the medium and with the consent of the copyhold commissioners; under the second to grant agricultural leases for a term not exceeding 21 years at a rackrent, building and repairing leases for a term not exceeding 99 years, and mining leases for a term not exceeding 60 years; and under the third, to purchase the interests of lessees, either by payment of a gross sum of money or by an annual charge upon the lands: at the same time power is given them to raise the necessary sum or sums by mortgage, with the consent of the copyhold commissioners. Power is also given them to raise money for other purposes, such as the erection and improvement of university and college buildings, and of the buildings on their estates (§ 27); and the Act is expressly declared to extend to lands held by them in trust or for special endowments. The Mortmain Act of 9 Geo. II. c. 36, which has put considerable obstacles in the way of gifts of land or money to be laid out in land in England for charitable purposes, does not extend to the two universities of Oxford and Cambridge, or to colleges in the two universities, nor to gifts in favour of the scholars of Eton, Winchester, and Westminster. This statute contained a restriction as to the number of advowsons which a college in either of the universities was allowed to hold; but this restriction was removed by 45 Geo. III. c. 101, having been found, as the preamble to this statute sets forth, injurious to learning. These colleges can therefore now purchase and hold as many advowsons as they please.

A collegiate church is a church that has a college or chapter of canons, but no bishop, and yet is under the authority of a bishop. (See Ayliffe's 'Parergon,' p. 167.) These collegiate churches are sometimes simply called colleges. In the case of Manchester College, a mandamus was directed to the Bishop of Chester, as warden of Manchester College, to admit a chaplain. The bishop happened also to be visitor of the college. It was held by the King's Bench, that in the case of a spiritual corporation the jurisdiction was in that court, unless there was an express visitor appointed; and the court interposed in the present case because there was no separate visitorial power then existing, owing to the union of the wardenship and visitorship in the same person. (Strange, 797.) This case was afterwards provided for by an express Act, 2 Geo. II. c. 29.

As to the relation between the English universities and the colleges within their limits, and the nature of a college in the English universities, considered simply in itself, see UNIVERSITY in this DIVISION; and CAMBRIDGE and OXFORD, in the GEOGRAPHICAL DIVISION.

The statutes of all the old colleges in England are in Latin; and, indeed, with the exception of some comparatively modern endowments, probably all college statutes are in Latin. Those of Eton College, of Trinity College, Cambridge, and of St. John's College, Cambridge, which may serve as specimens of the statutes of such foundations, are printed in the Education Reports of the House of Commons, 1818; and now the old statutes of the colleges of Oxford and Cambridge have been printed by the commissioners for enquiring into the two universities, the former in 1853, the latter in 1852. For the early history and privileges of the universities, see, among others, Wood's 'Historia Antiq. Oxon,' Ayliffe's 'State of Oxford University,' and Dyer's 'Privileges of the University of Cambridge.'

Meiners ('Geschichte der Enstehung und Entwickelung der Hohen Schullen,' &c., Göttingen, 1802, vol. i.) has given an interesting chapter on the origin of colleges in universities. The colleges in the University of Paris were the first institutions of the kind in Europe, though it is a mistake to suppose them older than the university itself.

The terms college and university have been often confounded in modern times, and indeed are now sometimes used indiscriminately. Some of the incorporated places of learning in the United States, which confer degrees, are called universities, and some are called colleges, though there is in fact no distinction between the two. Some of these institutions called colleges contain the schools or departments of arts, law, medicine, and theology; and some that are called universities contain only those of arts, law, and medicine. Some of these colleges are more limited as to the objects of instruction, but still confer degrees. If we look to the origin of colleges, and their connection with universities, it will be evident that the indiscriminate use of these terms is incorrect, and tends to lead to confusion. When an incorporated college, such as the College of Surgeons in London, is empowered to confer a degree or title after examination of candidates in a single department, some other name would be more appropriate. The word Academia, which is the most modern of all the terms applied to places of higher instruction, has been most usually applied to endowed corporate bodies which have for their object the improvement of some particular science or some particular branch of knowledge, in some cases with the power to confer degrees in such particular science, &c., and sometimes without this power. Yet the terms academia and university have also often been used, and now are used indiscriminately. (Meiners, vol. iv., 'On the Different Names of High Schools;' Huber and Newman, 'The English Universities,' vol. i.; and Savigny's 'Geschichte des Römischen Rechts im Mittelälter,' vol. iii., ch. 21.

The history of the Scotch universities shows that the terms college and university were, both at the time of the foundation of these institutions and subsequently also, used with little discrimination; and this carelessness in the application of the terms had led to anomalies in their constitution, and no little difficulty in comprehending the history and actual constitution of these bodies. (See the 'Report of the Royal Commission of Inquiry into the State of the Scotch Universities,' printed 1831; and Malden's 'Origin of Universities,' London, 1835.)

In France, the term college signifies a school, though the constitution of a French college is very different from that of our grammar-schools. It comes nearest, perhaps, to a German gymnasium. Of these colleges there are about 320, every large town having one of them. They are maintained by the towns, their heads and professors being paid out of the revenues of the communes. They are all under the superintendence of the University of France. There are also about 40 imperial colleges, in which the directors (*administrateurs*) and professors are paid by the state. The College Impériale of France, founded by Francis I., has above twenty professors, who lecture on the various sciences and the Oriental languages. (See 'Journal of Education,' No. III., 'On the State of Education in France.')

On the subject of colleges, from a legal point of view, the reader is strongly recommended to peruse an admirable argument on the rights of the fellows of Harvard University by the late Mr. Justice Story ('Miscell. Writings,' p. 294).

COLLIDINE ($C_{16}H_{11}N$). An organic base found in *bone oil*. It is isomeric with *xylidine*.

COLLIMATION, ERROR OF. In most instruments the line of sight is supposed to have a certain relation to other parts. Thus in a transit telescope it ought to be perpendicular to the horizontal axis, in a circle or quadrant it should be in a horizontal or vertical direction when the reading of the limb is 0° or 90°. When this is not the case, the difference between the existing and required positions is called the *error of collimation*, which must be carefully ascertained, and be corrected or allowed for, or eliminated in the mode of conducting the observations. This will be particularly explained as each instrument comes under our notice. Many readers will have a general notion of the error of collimation from the mode in which a workman tries the truth of his square, or of the mason's level, which in principle is nearly allied to the methods of astronomers. When the telescope was originally applied to astronomical instruments, the mystery of ascertaining the true direction of a line which could not be mechanically examined, presented considerable difficulties to some observers. Hevelius of Danzig never could be induced to apply telescopic sights to his sextants or quadrants, and in consequence of this prejudice much of the labour of his long and active life was completely wasted.

COLLIMATION, LINE OF, the line of sight in any astronomical or geodesical instrument. [CIRCLE.] Where a telescope is used, this name is given to the line joining the centre of the object-glass and the intersection of the fine wires or spiderwebs in its focus, this being the direction of any object which is there seen bisected by the observer.

COLLIMATOR, the name given by Captain Kater to his contrivance for determining the error of collimation in any principal instrument, without the reversal of the instrument itself. This reversal, troublesome in all large instruments, and in mural circles and quadrants, is forbidden by their construction. We shall give a sketch of Captain Kater's collimators and those antecedent to his invention, and a drawing and description of a *level* collimator, which on the whole we think best suited for common use. Where the adjustments, &c., mentioned are not described, the reader will find them in the article CIRCLE.

On referring to the description of each instrument, it will be seen that the determination of the error of collimation requires—1. A well-defined object, of which the direction remains unchanged; 2. A reversal of the instrument, similar to that of the mason's level; 3. For angular instruments, a power of determining the relation of the direction of that object to a vertical line. Now a near object cannot be seen on the wires of a telescope when they are in the focus of the object-glass, and a distant object is very seldom sufficiently steady or sharply defined. This want may be supplied by a second telescope, having its axis parallel to the axis of the telescope under examination and nearly in the same right line, which has cross-wires in its focus; the object-glasses being towards each other. As parallel rays falling on an object-glass converge to the focus, so rays diverging from the focus become parallel after refraction at the object-glass, and emerge as if they came from a real object at an infinite distance; hence the cross-wires in the supplementary or collimating telescope will be seen distinctly in the *direction* of the line joining the cross and the centre of the object-glass, in whatever part of the cylinder of issuing rays the eye may be placed. Great care is requisite in adjusting the wires of the collimating telescope exactly to focus, especially if a short telescope be used; but the axes of the two telescopes need only be approximately in a right line.

In many of the private observatories in England, a metal plate with sharp lines or dots engraved upon it, is firmly secured to an outside stone and viewed through a lens fixed in the wall of the observatory, the distance between the lens and the mark being equal to the focal distance of the lens. It is evident that such a mark may be used for determining the error of collimation in altitude of a reversible circle, and in all cases where merely a distinct and distant object is required. If the position of the mark be permanent, and the focal length of the lens be considerable, this may be advantageously used as a *meridian mark* [TRANSIT]; but then the lens should have a separate support within the observatory, and the position of the mark should be jealously watched and verified. Dr. Rittenhouse first made use of this substitute for a distant mark ('American Philosophical Transactions,' vol. ii. p. 181); and we believe Dr. Maskelyne at one time used an adaptation of the same principle, namely, a cap with a lens of long focus, slipping over the object end of his transit telescope, to view the south meridian mark at Greenwich, which was too near the observatory to be seen distinctly.

The collimating telescope and its cross-wires are thus made to supply the want of a distinct, distant, and immovable object. In the 'Astronomische Nachrichten,' No. 43, Professor Gauss, after enunciating the optical property above mentioned, used it for measuring the intervals between the wires of a transit telescope by a theodolet, which viewed them through the object-glass of the transit. In No. 61 of the same work, Professor Bessel applied the same principle to a still more important purpose, that of determining the horizontal flexure of the telescope of his meridian circle. After taking out the object-glass and eye-piece of this instrument (or the instrument might have been raised out of the way), he placed two collimating telescopes, one to the north and the other to the south of the circle, looking into each other, and nearly in the horizontal line which passed through the centre of his instrument. These he adjusted to have their cross-wires apparently upon each other, when the two object-glasses and the two crosses are evidently all in the same right line. The object-glass and eye-piece were then replaced in the circle telescope, and the angle between the two crosses of the collimator measured, which would have been exactly 180°, without flexure; hence the difference from 180° was the double horizontal flexure of the circle telescope. Bessel further remarks, that a vertical telescope turning freely round in its collars, and having a cross level attached, might be used for determining the true zenith point of any instrument, without reversing the latter. The date of this publication is July, 1824.

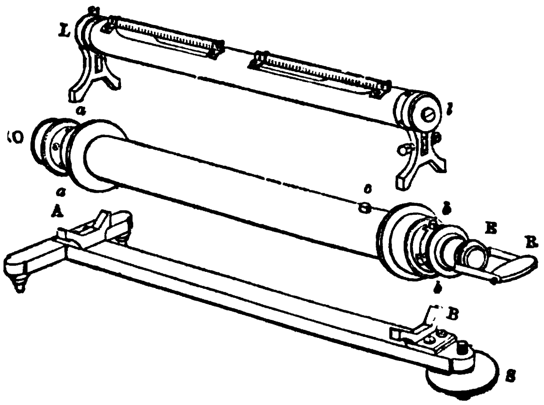
Captain Kater, who had not heard of either of these memoirs, gave, in the 'Philosophical Transactions,' 1825, p. 147, a description and figure of a *horizontal floating* collimator. This is a telescope laid horizontally upon a block of cast iron, which floats in a vessel filled with mercury. This collimator was designed for determining the *zenith point* of mural and other irreversible circles. The cross of the collimating telescope is observed by the circle telescope in one direction, suppose to the north, and the divisions read off. The trough of mercury with the collimator floating in it, is then transported to the south of the circle, the cross again bisected, and the divisions read off as before. If the angle which the line of sight of the collimating telescope makes with the horizon be supposed to be unchanged by this change of place, it is clear that half way between the means of the two sets of readings is the reading corresponding to the vertical position of the circle telescope. Again, as the difference of the north and south mean readings would equal 180°, if the collimating telescope were truly horizontal, half the excess of this difference above 180°, or half the defect from 180°, will be the angle which the collimating telescope makes with the horizon. We believe however that, in addition to the trouble of moving such an apparatus, the permanence of the position of the collimating telescope could not be relied upon if at all disturbed.

In the 'Philosophical Transactions,' 1828, p. 257, Captain Kater proposed a very much-improved form of this instrument, which he called the *vertical* floating collimator. The iron float is here a ring swimming in an annular trough, and the telescope, which is placed vertically, has a clear view through the centre of the float and trough. This collimator may be placed below the instrument to be examined, when the collimating telescope will have its object-glass uppermost, or, as is most usual, above the instrument, when the collimating telescope looks downwards. A smooth rotatory motion upon rollers can be given to the annular trough, when it is evident the line of sight of the collimating telescope will either be and continue to be vertical (supposing the position of the float to be permanent), or will describe a conical surface of which the axis is vertical. Hence, if the cross be bisected in two opposite positions of the collimator by the telescope of a circular instrument, the mean of the two readings will be the reading of the zenith of the instrument.

It will, generally speaking, be convenient to adjust the axis of the collimating telescope truly vertical. To do this first observe the position of the cross by a circle or transit telescope, turn the collimator half round, and note the position again; then, by placing a small weight upon the float, bring the cross half way between the two observed positions. Turn the collimator a quarter round and perform the same adjustment for this and its reversed situation. The axis of the collimating telescope is now truly vertical. From some trials, which however we must admit were not made under favourable circumstances, we do not think the vertical floating collimator capable of giving results as accurate as may be obtained by other means; but it ought also to be stated, that there is a good deal of difference of opinion among practical astronomers upon this point.

In the accompanying figure we have represented a more portable, and perhaps a more accurate instrument for determining the error of collimation, and also the position of the horizon, than either of the floating collimators.

The three parts of which this collimator consists have been separated from each other for easier comprehension. The telescope O E rests with its ground cylindrical collars, *a a*, *b b*, in the rectangular Y's, A, B of the stand. These collars should be truly cylindrical, and, if possible, exactly equal. There are cross-wires which must first of all be placed correctly in the focus of the object-glass, when the screw *c* is to be tightened. To adjust the cross-wires bring the intersection of the cross to bisect any distinct and immovable object (the wires of another telescope, for instance), turn the telescope half round in its Y's, and then, by releasing one of the four adjusting screws (the heads of which are seen near *b b*), and screwing up its antagonist, bring the cross *half way* back to coincidence, and complete the coincidence by screwing S. When this has been done satisfactorily, adjust the cross in the transverse direction by the other two screws, and it will then be found that the telescope can be turned round, without any apparent change of place in the cross-wires, that is, the line of sight is in the axis of the collars or parallel to the axis. The reflector R, which is merely to throw the light of the sky or a lamp upon the wires, may now be put on.



Level Collimator, Troughton and Simms.

The collimator being thus adjusted, is to be set to the north or south of the circle under examination, and at the same height as the centre of the telescope, when the axis of the collars is to be made horizontal by the reversible level *L l*, and the foot screw S. When the cross of the collimator is bisected by the wires of the circle telescope, the telescope is horizontal, and the mean reading of the circle microscope is the reading of the *horizontal point*, which, if the circle reads altitudes, should be 0°, and if zenith distances, should be 90°. The difference from these values is the error of collimation. By setting the collimator to the other side of the instrument any error of flexure may be detected.

We have said that the cylindrical collars should be perfectly equal, but it is not easy to make them so. The difference is easily ascertained by reversing the telescope in its Y's, end for end, and again applying the level. Suppose the level to have shown perfect horizontality before reversing, and that afterwards the reading towards O exceeds that towards E, by m''. It will easily be seen that $\frac{m''}{4}$ must always be *subtracted* from the indications of the level towards O. It is equally evident, that if, after the above correction is made, the object end O appears too high by n'', that the true angle with the vertical is $90 + n''$, or that the reading of the circle should show n'' of depression. The different cases which may occur present no difficulty. If the collars are truly cylindrical and the level a delicate one, such a collimator should show the true horizontal point within $1''$. The telescope should not be very small, not less than 12 inches.

It would scarcely be just not to notice under this head an instrument by Roëmer, which has as much merit, as an invention, as any of these which we have described. It consists of two equal lenses fixed in a tube at a distance somewhat exceeding their focal length, with a system of wires in the focus of each, between the glasses. By applying the proper eye-piece at each end, the near wires, and consequently objects through the most distant object-glass, are made visible. The two object-glasses and the crosses of the wires being all adjusted in the same straight line, it is evident that, on looking in at each end of the tube, objects 180° apart will be seen on the crosses. Roëmer called this tube an *amphioptron*, or *reciprocal telescope*, and used it for the transit adjustment in collimation of his *rota meridiana*. (Horrebow, 'Basis Astronomiæ,' p. 97.)

For further details, see Pearson's 'Practical Astronomy,' vol. ii. p. 446, plate xxi.

COLLISION, IMPACT, or PERCUSSION OF BODIES, is that part of Dynamics in which are contemplated the effects arising from the striking against each other of two bodies, one or both of which are in motion, and answers to the *choc des corps* of French treatises.

It is usual to treat the first principles of this subject by supposing the bodies in question to be spherical; and for the following reason: When a body receives a blow, if it be free to turn as well as to move forward, a rotatory motion is, generally speaking, produced, as well as a motion of translation. But if the direction of the blow be in a line which passes through the centre of gravity, no rotatory motion is produced. Now if two equal spheres move upon a plane, it is obvious that when either strikes the other, the direction of the blow passes through the centre of gravity. Making use then of equal spherical balls, of the same or different weights, moving upon a level plane, let it be remembered that all conclusions apply equally to bodies of any form, having no rotatory motion, and striking each other in such a way that the line joining their centres of gravity passes through the point of contact at the moment when they strike.

The simple mathematical theory of impact proceeds, like other mechanical theories, upon suppositions which can only be approximately obtained in practice. For instance, if in the preceding supposition the level plane and the balls exercise any friction on each other, the consequence will be that the balls will begin to roll on the table, even though the blows which set them in motion pass through their centres. To the existence of this friction are due many phenomena which a game of billiards will present, and which will not result from the common theory. Let the table, then, be supposed to exert no friction on the balls, so that one of the latter, struck by a blow the direction of which passes through the centre, will move along the table without rolling.

Let us now suppose the ball A to be impelled directly towards an immovable obstacle, such as an upright ledge at the end of the table. On striking this ledge, the ball will, generally speaking, recoil more or less. Some substances will hardly give any recoil, while others will send the ball back with nearly the same velocity as that of its approach. This spring or elasticity is more easily measured than explained; it arises in the following manner: At the moment of impact, the ball compresses the part of the obstacle against which it strikes, which pressure continues until the reaction of the obstacle has destroyed all the velocity of the ball. At the same time the parts of the ball close to the point of impact have been compressed in a similar manner. If then there were no effort in the parts of the obstacle nor in those of the ball to recover their former position, the ball would remain at rest, close to the obstacle. If the recoil were complete, that is, if the parts of both bodies endeavoured to recover their position with a force equal to that which disturbed them, the recoil would rapidly but gradually create in the ball a velocity equal to that with which it approached. These two cases are the theoretical extremes which it is most probable no material bodies attain: in the first case they are said to be wholly inelastic, and in the second the elasticity is said to be perfect. But if only a fraction e of the velocity of approach be restored, then e is said to be the measure of the elasticity of the bodies.

In treating of the theoretical effects of impact, many authors have ascribed to bodies the hypothetical property of perfect hardness or incompressibility. This, however, is quite gratuitous, for Mr. Hodgkinson has not found in the course of his experiments (see 'British Association Reports,' vol. iii. p. 534), any matter perfectly fulfilling these conditions. Hence the value of e for all known substances is a positive proper fraction, which represents the ratio that the force of restitution bears to the compressing force, that is,—

$$e = \frac{\text{force of restitution.}}{\text{force of compression.}}$$

This quantity e must not be confounded with the *modulus of elasticity*. [ELASTICITY.]

The value of e for some common substances is as follows:—

Glass	=	0·94	Bell-metal	=	0·67
Ivory	=	0·81	Cork	=	0·65
Steel	=	0·79	Brass	=	0·41
Cast-iron	=	0·73	Lead	=	0·80

If the striking bodies have spherical forms so that the contact may take place, at the first instant, in a point, their surfaces about that point will have their figures changed; and if the bodies have different degrees of hardness, an indentation may take place in that which is the least hard, the other penetrating to a certain distance in it. When the bodies are soft, like balls of wet clay, the change of figure produced by collision is manifest; but when two balls possess an elasticity which is nearly perfect, they so far recover their original figure after impact, that the change is not perceptible: it may be rendered evident, however, by covering one of the spheres with ink and suffering it to impinge on the other, the latter then receives a stain which, instead of being a point, is a circle of sensible magnitude; and this proves that the surfaces must have been flattened at the point of impact.

Impact has been termed a "pressure of short duration;" but practically there is a great difference between the effects of pressure and impact: thus, a very large weight will be required to press a nail into a block of wood, which may be readily driven into it by a small hammer; and the reason is, that a longitudinal compression of the nail towards the head takes place, which is followed by restitution, and these actions follow each other successively, and the nail enters by a kind of *vermicular* action, like that of a *worm* progressing through the earth.

Also, when impact is employed to communicate motion to one body relatively to another, the effect produced depends greatly on the immobility of the latter; thus, many more blows will be required to drive a nail into a *loose* board, than would suffice if the latter were fixed; although, in certain cases, as in the breaking of minerals, &c., the effect of impact is diminished by a firm support. Here, probably, the effect of momentum on the successive particles is interfered with by a contrary momentum generated by restitution.

In order to account for the effect of percussion in impelling a body, a wedge for example, being much greater than that of mere pressure,—it may be observed that both effects depend on the product of the mass of the impelling body and its velocity: but, when a body moves in consequence of pressure, the velocity is extremely small; therefore, in order that the effect of simple pressure may be equal to that of percussion, the mass imposed must be very great. It is evident, however, from what has been said, that the two forces are of the same nature. It should be added, here, that the shock produced in a material, when divided by a wedge, or penetrated by a nail, either of these being driven with a force produced by a sudden blow of a hammer may, by displacing the particles of the material, diminish their cohesive power; and this may be, in part, the reason that the effect of percussion often exceeds that of a weight many hundred times greater than that of the hammer.

The force of elasticity is very different in different bodies: spheres of glass are those in which the force of restitution (after impact) approaches nearest to the force of compression; and, in such spheres, the ratio between the forces is as 15 to 16: in spheres of ivory the ratio is as 8 to 9; and in spheres of steel, as 5 to 9.

The bodies upon which experiments on collision are usually made are generally of a spherical form; in order that when they impinge upon one another directly it may be indifferent at what part of the surfaces of the bodies the contact takes place: the bodies are usually suspended by a string or rod from fixed points; and they are made to impinge upon one another while describing circular arcs, in a vertical plane, about the point of suspension. The absolute momentum, or quantity of motion in a body, is represented by the product of its mass and the velocity with which it is moving: but the effects of the collision of two bodies depend on their relative velocity, or that with which they approach to, or move from, one another; this is consequently the sum of the absolute velocities when the bodies, in approaching each other, move in opposite directions, and the difference when they move in the same direction.

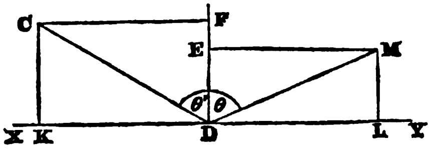
The principles upon which are determined the velocities after impact of different balls which strike one another are as follow:—

1. If two perfectly inelastic balls move towards each other in opposite directions, and with velocities inversely proportional to their weights or masses, they will destroy each other's velocities and remain at rest. Thus if A were twice as heavy as B, but if B moved twice as fast as A, there would be no motion after impact. [MOMENTUM; MOTION, LAWS OF.] Let a be the velocity of A, and b of B; then A and B being expressed in the same units of weight, and a and b in the same units of length and time, the preceding condition is fulfilled when $\mathrm{A}a=\mathrm{B}b$.

2. If the same velocities be added to or taken from both balls, so that their rate of approach is not altered, the forces exerted in the shock will not be altered, nor will the rate of recess after the shock. Thus a cannon-ball rebounding from a wall, both having the motion of the earth, strikes with the same force and rebounds in the same manner as it would do if the motion of the earth were taken from both, or if the earth were at rest.

Now, suppose the ball A (which is so small that its size may be neglected) to approach obliquely towards the obstacle XY, say in the direction CD. Let CD be the velocity, or length moved over in one second. Then [VELOCITY] the velocity CD is equivalent to the two

Fig. 1.



velocities CK and KD. The first is destroyed, and then partially restored by the impact; the second remains unaltered, except by the friction at the moment of impact, which we do not consider. If then we take DL equal to KD, and draw LM perpendicular to XY, and in length such a fraction of KC as e is of 1, the ball will move after impact with the velocities DL and LM, that is, with the velocity DM in the direction DM. If the system were perfectly inelastic, the ball would proceed along DL; if perfectly elastic, ML would be equal to CK, and DM and CD equally inclined to XY. If the size of the ball be taken into account, XY must be supposed to be a line parallel to the obstacle, and distant from it by the radius of the ball.

Direct impact and collision. Let the masses of the two balls or material particles be m and m', and let them move with uniform velocities v and v' in the same direction along a straight line, v being greater than v', so that m overtakes m'. Let u be the common velocity of the two balls when the compression at the moment of impact is a maximum; let P be the momentum spent in producing this compression, and ϵP the momentum acquired during the restitution of the form of the bodies, ϵ being the coefficient of elasticity. Let V and V' be the velocities of the balls when collision ceases. Hence, we have the three following cases :—

(1.) $m\,v$ = momentum of m at the beginning of collision.
P = momentum spent in producing compression.
$m\,u$ = momentum of m, when compression is a *max.*—

$$\therefore m\,v = m\,u + \text{P}.$$

(2.) $m'v'$ = momentum of m' at the beginning of collision.
$m'u$ = momentum of m', when compression is a *max.*—

$$\therefore m'\,v' = m'\,u - \text{P}.$$

(3.) At the instant when collision ceases, we have similarly,

$$m\,\text{V} = m\,u - \epsilon\,\text{P}.$$
$$m'\text{V}' = m'u + \epsilon\,\text{P}.$$

from which equations we shall get

$$u = \frac{m\,v + m'\,v'}{m + m'} = \frac{m\,\text{V} + m'\,\text{V}'}{m + m'}$$

$$\text{P} = \frac{m\,m'}{m + m'}\,(v - v')$$

$$\text{V} = \frac{m\,v + m'v'}{m + m'} - \frac{\epsilon\,m}{m + m'}\,(v - v'), \text{and } \text{V}' = \frac{m\,v + m'\,v'}{m + m'} + \frac{\epsilon\,m}{m + m'},\,(v - v').$$

Oblique impact and collision. In oblique impact we assume that the mutual action of the balls during collision is along the line joining their centres at the instant when compression is a maximum, and along that line only; that is, we assume the balls to be perfectly smooth. Hence, if a smooth ball impinges obliquely on a smooth plane, the line of reaction of the plane will be perpendicular to its surface, and the momentum of the impinging ball will be affected along that line only.

In *fig.* 1, let the ball C impinge at D, and be carried away to M; let v and v' be the velocities before and after impact, and which are therefore proportioned to CD and DM.

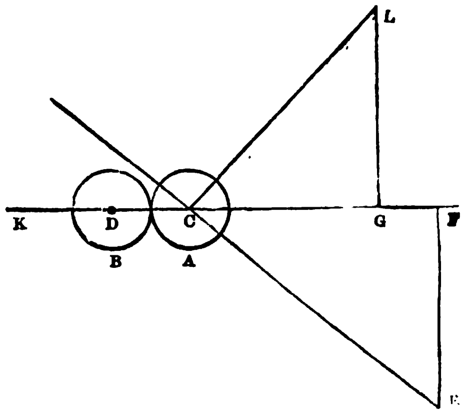
$$\therefore \frac{v}{v'} = \frac{\text{CD}}{\text{DM}} = \frac{\dfrac{\text{CF}}{\sin\theta'}}{\dfrac{\text{ME}}{\sin\theta}} = \frac{\text{CF}}{\text{ME}}.\ \frac{\sin\theta}{\sin\theta'} = \frac{\sin\theta}{\sin\theta'}$$

$$\text{and } \epsilon = \frac{\text{DE}}{\text{DF}} = \frac{\text{FC}}{\text{ME}}.\ \frac{\text{DE}}{\text{DF}} = \frac{\dfrac{\text{FC}}{\text{DF}}}{\dfrac{\text{ME}}{\text{DE}}} = \frac{\tan\theta'}{\tan\theta}$$

The equations for the impact of two smooth balls are similarly formed, and may be easily understood from their analogy to those given above for *direct* impact. Thus, suppose two balls A and B to move in directions *oblique* to one another, and to strike each other. Decompose the velocity of each ball into two, one in the line joining the centres at the moment of impact, and the other perpendicular to it. The pair of velocities perpendicular to the central line will not be altered by the impact; and as far as the remaining velocities are concerned, the case is precisely the one already solved. Find the velocities in the central line as altered by the impact, compound them with the perpendicular velocities which remain unaltered, and the resulting velocities and directions will be those with which the balls will proceed after the impact.

To take the most simple case, suppose the ball A, moving in the direction EC, and with the velocity EC, to strike the ball B, which is at rest. Join D and C, the centres of the balls, and decompose EC into FC in the line joining the centres, and EF perpendicular to it. Then A will only strike the ball B with the velocity FC.

Fig. 2.



Suppose that by the preceding rules it is found that A, striking B at rest with the velocity FC, will be thrown back with the velocity CG, while B is struck forward with the velocity DK. Then B will receive this velocity, and this one only; as to A it has after the impact acquired the velocity CG, which it combines with the velocity GL, equal and parallel to EF; so that CL represents the velocity and the direction of the motion of A after the impact.

In every case of impact, when the balls approach one another with uniform velocities, the centre of gravity of the balls moves uniformly, and in a straight line. After the impact, though the directions and velocities of the balls may have changed, yet their centre of gravity still continues to describe the same line, and with the same velocity as before. This proposition is proved in all works on elementary mechanics.

The following conclusions will now be readily deduced by any one who understands the preceding results :—

1. If two inelastic balls move in the same direction, they do not separate after the impact, but either move on with a common velocity, or are reduced to rest. If both move in the same direction, the velocity after impact is $(\text{A}a + \text{B}b) \div (\text{A} + \text{B})$; but if they move in different directions, the motion after impact is in the direction of that ball of which the momentum ($\text{A}a$ or $\text{B}b$) is the greatest, and the velocity is $(\text{A}a - \text{B}b) \div (\text{A} + \text{B})$ or $(\text{B}b - \text{A}a) \div (\text{A} + \text{B})$. When the momenta are equal, there is no motion after the impact. If $b = 0$, or if one of the balls be at rest before impact, the velocity after impact is $\text{A}a \div (\text{A} + \text{B})$. To deduce these results, make $e = 0$ in the formulæ, and give the velocities their proper signs.

2. If two perfectly elastic balls move in the same direction they separate after the impact, the velocity of the foremost being augmented from b to $b + 2(a - b)\text{A} \div (\text{A} + \text{B})$. But the velocity of the hindmost is either retarded, altogether destroyed, or made to change its direction, the algebraical formula for the velocity after impact being $a - 2(a - b)\text{B} \div (\text{A} + \text{B})$. This is nothing when B exceeds A, and when b is to a as $\text{B} - \text{A}$ is to 2B. And according as b is to a in a less or greater ratio than the preceding ratio, A's velocity is or is not altered in direction.

If two perfectly elastic balls move in opposite directions, that of A being called positive, the velocities of A and B after impact are determined in magnitude and direction by the formulæ

$$a - (a + b)\,\frac{2\text{B}}{\text{A} + \text{B}} \text{ and} -b + (a + b)\,\frac{2\text{A}}{\text{A} + \text{B}}.$$

4. If two perfectly elastic balls be equal in magnitude, the velocity of each after the impact is that which the other had before the impact, both in magnitude and direction.

5. In all cases perfectly elastic balls recede from each other after impact with the same velocity with which they approached before impact; since if $e = 1, v - u = a - b$. But in every other case the rate of recess after impact is the same proportion of the rate of approach before impact which e is of 1.

6. The *vis viva*, or product of the mass and *square* of the velocity, of a couple of perfectly elastic balls is the same before and after impact; in every other case it is less after impact than before.

For further mathematical developments and deductions from these general formulæ, we may refer especially to Professor Price's treatise on 'Infinitesimal Calculus,' vol. iii. c. 8 and 10; to Golding Bird's 'Natural Philosophy,' p. 134, *et seq.*; and to Professor Walker's treatise on 'Mechanics,' c. vii. p. 173.

COLLISIONS AT SEA. The accidental contact of vessels which traverse the ocean and the numerous channels and roadsteads of Europe, is a painful feature of commerce; because the extension of commerce must increase in fearful ratio the chances of calamities which are known as collisions at sea.

These calamities present to us danger to human life in a new aspect. Its novelty consists not so much in the peculiarly frightful nature of accidents of this class, as in the *causes* which produce them. In the olden time, or even within the memory of the present generation, when ships ran foul of each other, it was seldom that loss of life attended these mishaps; and in the Channels the amount of damage would frequently extend, perhaps, to the loss of an anchor or two, the starting of a butt-end, or, perhaps, a crash not difficult to patch up until some port could be gained. The form of our shipping in those days was rather adapted to the carrying of burthens than for speed; and consequently, from the fuller lines of the bow of the ship the blow was distributed over a greater surface of timber, when ships were, moreover, built with greater strength.

Now, however, not only do ships, as a general rule, possess increase of speed, but their lines are so adjusted as to present the least possible resistance in their forward end, and their bows are absolutely wedge-like. Nor is this all; for instead of the fore-part of the stem-piece itself being 12 or 14 inches in thickness, many iron steamers of thousands of tons burthen present no more breadth of stem at the fore-part than belongs to a London wherry. Hence, in these times, circumstances seem to *conspire* towards the increase of danger in collisions; and from the combined influences of increased speed and the sharpness of stems, vessels at sea are really and daily in danger of being literally cut in two. In reading tales of chivalry, our horror may have been deep at the description of prowess and strength which would cleave a man to the brisket: shall we be unmoved now, when we hear of a fine ship being in like manner, and without any warning, cut through timbers and bulkhead, and windlass and deck, almost to the fore-mast itself? Yet such *has occurred*, and is always threatening. In the collision between the Mail and the Excelsior, off Birkenhead, in 1856, even worse than this happened, for the whole of the unfortunate passengers who were sleeping forward were in one instant crushed, and mangled, and destroyed in the general wreck, from the *cutting-down* blow of a sharp stem!

Thus collisions at sea must be viewed as evils of very great magnitude, requiring energetic and watchful legislation for their prevention; for, in addition to the changes in the mere forms of shipping referred to, another element of mischief is looming in the fast-diminishing distance,—it is the increased *size* of shipping. Collisions, it is true, have *only* hitherto sent *dozens* of our fellow-creatures suddenly into eternity; but the period is at hand when these dozens may become *hundreds*, perhaps *thousands*, unless some more powerful influences are called into more active operation to prevent it. It is peculiarly the duty of a Cyclopædia to grapple impartially with any question in arts and sciences resulting from *progress*, and to examine the various subjects of its contents, in order to detect new features which menace, or to watch known aspects which indicate changes; and this subject will accordingly receive our proper attention.

The great difficulty of the question of collision is perhaps the prevailing erroneous idea that it is merely a nautical question; while, in reality, it affects directly the whole community, as passengers of ships are the members alike of coast-resident and inland families; and it is remarkable that ships carrying only their ordinary crews seem to have been less liable to the accidents under consideration than those carrying passengers.

An extraordinary fact has been elicited from the careful investigation of accidents which occurred in 1856. One would naturally have expected to find that collisions would especially occur during the time of fog or haze, or certainly in the hours of darkness; but the editor of the 'Nautical Magazine' has produced a statement or abstract in that valuable periodical, in which we find the following table of the collisions in 1856. ('Nautical Mag.,' Nov., 1857):—

STATE OF WEATHER.	BY DAY. (6 A.M. to 6 P.M.)	BY NIGHT. (6 P.M. to 6 A.M.)	TOTAL COLLISIONS.
Dark	0	31	31
Dark and clear . .	2	4	6
Very dark . . .	0	5	5
Hazy	12	80	92
Cloudy . . .	9	20	29
Thick and foggy . .	5	19	24
Clear	36	81	117
Unknown . . .	2	10	12
Total . . .	66	250	316

From the above it actually appears that the *greater number* of collisions occur in *clear* weather, and the *least* number in dark or thick weather. To whom, then, can we, in a spirit of impartiality, impute culpability? When mariners themselves are so seriously implicated, we can only turn imploringly (as in the cause of humanity) to the authorities themselves. It is easy to accuse even these of neglect, but it would really be difficult to convict them even of indifference. The collection of materials for the above table is of itself a proof that the government of the country is alive to the importance of the question, that the naval heads of the Board of Trade are anxious to remedy this crying evil, this standing blot upon our *seamanship* and *vigilance*. The only inference an impartial public can draw is, that the *onus* and *odium* of the fault must rest, in a great measure, with the officers of ships themselves. It is well to consider if the comparative exemption of ships of war from collision arises from better discipline—better look-out. From the above it is evident that,

1st, More attention is called for on board merchant-ships generally;
2nd, The rules of the road *by day* may be defective;
3rd, The rules of the road *by night* may be defective also.

Probably legislation can only partially present a remedy for the defect first mentioned. Surely it is beneath the dignity of a British sailor, either to *run into* or *be run into* by any craft that floats. There was a time when *vigilance* formed the very key-stone in the character of the English seaman; it is hoped the present generation will maintain this character. It may be that the changes from sailing to steaming have unsettled the habits of seamen, and that, in the confusion, accidents, for a time unavoidable, may occur; but is it not reasonable to expect that every merchant vessel should have at least one able seaman in each watch whose duty and responsibility should be to prevent collision? Surely precautions and responsibilities which attach to railway officials, might without hardship be enforced on, and attached to, officers of the mercantile marine, where such very serious interests of life and property are at stake. But legislation may be greatly assisted by some conventional, better-understood rules among ship-masters themselves; as for instance, larger steamers, being often difficult to steer readily, and drawing more water, should claim a proper consideration from smaller ones. A few examples made by the Board of Trade, in the salutary punishment of obstinate or unyielding masters of small craft, might, in river or estuary navigation, partially remove danger.

As regards the second assumption, namely, defective rules of the road by day, it is extremely difficult to know where to place the limit between stringent law and freedom of judgment. Nay, it may even be demonstrated, that compliance with any known law or rule as to the movement of the helm, *irrespective of the judgment of the helmsman*, would prove in many cases disastrous; and those who attempt by diagrams to illustrate any proposed rule, ought to remember that, in order to render their illustrations acceptable and useful, the vessels must not only be supposed to answer their helms with equal readiness, but their speed must be precisely similar. A discretionary power in commanders, by day, seems to be more valuable than all regulations, excepting such good old ones for sailing-vessels as starboard tack hold on, port tack give way, &c.; and for steamers, *a good look-out, a good man at the helm*, and *passing each other on the port side, &c.*, ought to be enough.

In crowded rivers or channels, something might be done towards the greater safety of navigation. Something is, in fact, *called for*, on account of the various customs which prevail in certain districts; but a knowledge of them seems to be confined to the localities. And committees and others who have approached the question of collisions at sea, all seem to have neglected to give due prominence to the want of attention to that which is the root of evil,—namely, that when ships are approaching in opposite or oblique directions, no collision would be likely to take place *if one commander knew what the other was about to do with his helm.* Positive safety hinges on this.

So little however is this precious hint known or sought for in general, that, absolutely, a man-of-war steamer navigating the Thames, and meeting a river steamer, would use signs to her helmsman having *opposite significations* in each vessel; that is to say, for instance, the naval commander extending his hand to signify to his helmsman port, might be understood by the river steamer's rule to be about to starboard the helm. There is no rule of the road as enforced by law to prevent this: if any exists, the writer distinctly assures the public that it is not generally known, and even naval officers are left to their own judgment in this matter. And again, as if still further to complicate this serious question, a commander in each service will give his order by hand, according as he is fitted with a *wheel* or a *tiller*; for, as an example, motion of the hand generally indicates the direction in which motion is to be communicated to the part of the steering apparatus which is touched by the hand [STEERING APPARATUS], and the spokes of the wheel move in a direction contrary to that of the tiller. Without the aid, therefore, of some further legislation, can we hope to prevent collisions? It may, moreover, be remarked, that if two persons are meeting carelessly on a pavement, collision is only avoided by one of the two *knowing in proper time what the other is about to do.* The same remark applies to shipping: a ready means of knowing *in time* the intended motions of an opponent seems indispensable to safety. Some such rule, therefore, as the following is much wanted: When a commander (throughout the world, if possible), seeing another vessel approach, extends his right arm horizontally, let it signify to his own helmsman—starboard the helm; let the extension of his left arm signify to his own helmsman—port your helm. His opponent, seeing this, could act *on the moment*, and would know what to do accordingly. If in a steamer and about to stop her, let both his arms be held up while he gives the word. *Accidents by day could, under such simple rules, scarcely occur.*

In remarking upon the third assumption, that the rules of the road by night may be defective, we enter upon a wider field of inquiry; and although we purpose going somewhat fully into the question of lights at sea in its proper place in this work [LIGHTS AT SEA], we remark here how very plainly the tabular abstract given in a previous column shows, that if any system of lighting vessels under way did exist in 1856, that system required amendment. Some considerable improvement has indeed been made, after long and elaborate investigations, by the Board of Trade, through ship-masters, pilots, boatmen, &c., and evidence from all ports of Great Britain; yet we can show that great defects still mar the perfect working of the new regulations; and it is probable that the greater number of accidents by night from collision will still (as in 1856) abound on the parts of the coast which are best lighted, such as Dungeness, Beachy Head, the Start Point, &c.; for it is reasonable to suppose, that the more vessels congregate at those headlands, the more must the confusion of lights increase, as they are at present ordered to be used by sailing- *and* steam-vessels, each steamer having three and each sailing-vessel two lights. To distinguish a steamer from a sailing-vessel, the law wisely requires the steamer to carry a white light *on the mast, besides* the green and red lights, one on each side; while the sailing-vessel carries only the coloured lights, except when at anchor. Now, imagine a vessel suddenly entering a channel much frequented by steamers; every steam-vessel in sight will cause anxiety to every sailing or steam master, because the white light is seen all round, and the intensity of the various-coloured lights is so uncertain, especially in hazy weather, that a ship near at hand may exhibit coloured lights which are scarcely visible, while one more distant may show strong ones. Now, confusion and anxiety would, it is evident, be caused to a mariner mainly by the number of white lights indicating *steamers*, each of which lights would require scrutiny to ascertain its connection or otherwise with coloured lights of a vessel under way; but what is now proposed would completely remedy this.

The following improvements, exceedingly simple in themselves, and very easy to be adopted, are submitted as a perfect and unobjectionable night system:—

1. *Let a white light always be considered a danger light.*

2. Let steamers *and* sailing-vessels carry the screened coloured lights as at present; namely, green on the starboard side, red on the port side. But let these lights be placed abreast the foremast; at present they are often fixed upon the quarter, and consequently become shut in too soon.

3. Let all vessels, sailing or otherwise, when within soundings, carry also by night a white light.

4. Let steamers carry their white light at the mast, or *high* on the fore-stay; and sailing-vessels carry it at the bowsprit end, or somewhere *low* as convenient amidships.

5. Let all vessels at anchor carry a white light, showing all round, but not placed so high as to be mistaken for a steamer's: the absence of the coloured lights will always, as at present, show that it is only a vessel at anchor.

6. *Let all white lights of vessels under way be so fixed and screened as only to be seen within a space of two points on either bow;* and in case of a fast vessel overtaking a slower one, and in her wake, *let* all white lights of vessels under way be screened so as to be visible from abaft within one point of the line of keel astern. (This can easily be done.)

These precautions being adopted, no confusion can embarrass a master mariner, because on entering a port, if a hundred vessels be there under sail or steam, he, so far as regards danger of being run into, need only notice the white or danger lights; these being "shut in," and there being a good average and trusty look out forward, confidence will not forsake a shipmaster or pilot, and the safety of his vessel will be in his own control; *at present it is not*, although the present system of shutting in a coloured light is good *so far as it goes*. In using, however, the danger light, some assistance can be given similar in effect to that produced by day, having for its object the power of immediately indicating and ascertaining *what each master is about to do.*

7. Let it therefore be a law that each commander or pilot has, between sunset and sunrise, always a hand-lantern ready lighted and standing on the paddle-box or near him, as most convenient; and being of one wick, having three faces (such are used on railways); the centre light being white, the left-hand one red, and the one on the right hand green. On seeing a danger-light near, if he intends to keep straight on, let him flash or swing his lantern with his white light towards his opponent's; if he is about to starboard his helm, let him exhibit his green light; if to port his helm, let him show his red light.

A few additional precautions or modifications may to some appear necessary; but the principle of a danger light is in our sea services necessary to the public safety; and while our object in giving to the public the actual state of the question is rather to *suggest* than to *dictate*, it is fully believed that, by attention to some such system as the above, collisions at sea may be rendered nearly impossible both by day and night, except from *culpable negligence.*

Another very important suggestion as to collisions at sea was published in the 'Nautical Magazine' in 1857. Mr. George Herbert, as already noticed under the word BUOYS in this work, proposed to so arrange or dispose of the traffic in the English and St. George's Channels as to give to maritime commerce what in its nature approximates closely to a tram-road system. The smile of incredulity and doubt is too readily raised in nautical men, nor can we be astonished if the minds of those who were trained in the old sea school are as yet unprepared for the great changes which every day's experience render more than probable. But we must be guarded, and not encourage rooted prejudices on subjects which require all our wisdom and vigilance. It is scarcely a reproach to the present age, that the scheme of penny postage, the screw steamer, the electric telegraph, &c., met with distrust. In this instance it is enough for us (and with that impartiality which ought to influence statements of the present condition of arts and science) to record the beginnings of a change which may take years to perfect; to make known suggestions, which, if it be found possible to be carried out, may greatly facilitate the transit of passengers and merchandise through the most perilous parts of a sea voyage, and prevent collisions, fifty-eight of which occurred in the English Channel alone in the year 1856, eight being attended with total loss.

Mr. Herbert's proposition seems to be founded on a remarkably simple assumption; namely, that we almost never hear of a vessel running foul of the Eddystone Lighthouse. He proposes, therefore, to moor light-vessels of a peculiar form (a general sketch of which has been given under the word BUOYS) in the English Channel, precisely in the generally received line of fairway, and to cause all ships and vessels bound down Channel to keep to the northward of this line, and all bound up Channel to navigate on the south side of this limit. To place light-vessels along this fairway line from Dungeness to just beyond the Scilly Islands, each light-vessel to be moored on the meridian of a degree of longitude. By this means the light-ships would in the latitude of the Channel be only about 38 miles apart, and each would be marked with a conspicuous number indicating its longitude. Vessels in the fairway track could never in fair weather be far out of sight of some one of those lights after sunset.

That some such plan as the above would be a boon to shipping can scarcely admit of a reasonable doubt; but when we remark, further, that Mr. Herbert's plan is extended to highly interesting details,—such as having a store of provisions and water at the westernmost light-ship, for the relief of those so frequently detained by adverse winds for several weeks, and to relieve whom, at present, the Admiralty are obliged occasionally to send ships of war; to have effective fog-signals at each light-vessel; to have a submarine telegraph to the westernmost light, in order that arrivals may be announced,—these, and various other ingenious and valuable suggestions, seem to be worthy of an impartial investigation by the Board of Trade. In the cause of humanity, as having reference only to the question of collision in the English and St. George's Channels, surely the endeavour to prevent accidents to life and property on so great a scale should not be impeded by merely speculative and perhaps visionary obstacles, and possibly by the unfounded disparagements which *novelties*, as such, too often evoke.

The responsibility of introducing some such scheme as the above would weigh lightly when placed in the balance with the responsibilities which far more heavily attach to supineness and indifference.

COLOCYNTH, or as it is called on the Continent, coloquintida, or bitter-apple, an annual plant. [CUCUMIS, in NAT. HIST. DIV.] Referred in 'the London Pharmacopœia,' to the genus *Citrullus* (Schrad.), the fruit of which is about the size of, but rather lighter colour than, an orange; the rind smooth; when the rind has been removed, a white spongy pulp or pith is found within, which constitutes the officinal part, or the colocynth, the seeds being rejected. The rind is generally removed before reaching Europe, except the larger variety from Mogadore, used for exhibiting in show-bottles in druggists' windows. One hundred parts of decorticated apples consist of twenty-eight parts of pure pith, and seventy-two parts of seeds.

The active principle is a peculiar bitter principle (Colocynthin), which is of a resinoid nature, more soluble in alcohol than water; its solubility in water is much increased by union with extractive, combined with which it exists in the pulp, so that nearly all the virtues are yielded to a watery extract, which is generally employed for its administration. The compound extract, in the formation of which proof spirit is used, and to which are added other purgative substances and aromatics, is, however, preferable, and it is thereby rendered milder yet more certain in its action.

It is a purgative in very constant use, either alone, or more commonly united with mercurial purgatives: it is employed for the removal of constipation and visceral obstructions; at the commencement of fevers and other inflammatory complaints it is of decided utility. As an overdose has all the poisonous effect of a vegetable acrid, it must be used with caution.

COLOMBIC ACID ($C_{42}H_{23}O_{13}$?). An acid, little known, contained in colombo root (*Cocculus palmatus*).

COLOMBIN ($C_{42}H_{22}O_{14}$?). The active principle of the colombo root. It is neutral, crystalline, and only slightly soluble in cold water, alcohol, or ether.

COLONEL, the commander of a regiment or battalion of troops; he is the highest in rank of those called field officers, and is immediately subordinate to a general of division.

The derivation of the word is uncertain. It is supposed to have been given originally to the leader of a body of men appointed to found a colony; or to have come from the word *coronarius*, indicating the ceremony of investing an officer with the command of a corps; or, finally, from the word *columna*, denoting the strength or support of an army.

The title of colonel-general was, for the first time, conferred by Francis I., about the year 1545, on officers commanding considerable divisions of French troops, though, according to Brantome, it had been given to the chief of an Albanian corps in the service of France at an earlier period. When the troops of that country were formed into regiments (the infantry about 1565, and the cavalry seventy years afterwards), the chiefs of those corps were designated *Mestres de Camp;* and it was not till 1661, when Louis XIV. suppressed the office of colonel-general of infantry, that the commanders of regiments had the title of colonel.

In England, the constitution of the army was formed chiefly on the model of the French military force; and the terms regiment and colonel-general were introduced into this country during the reign of Elizabeth. It must, moreover, be observed, that in the regulations made by the citizens of London for forming the militia in 1585, it is proposed to appoint *colonels* having authority over ten captains; and that both colonels and lieutenant-colonels are distinctly mentioned in the account of the army which was raised in order to oppose the threatened invasion of the country in 1588. Before the time of Elizabeth, it appears that the commanders of bodies of troops equivalent to regiments had only the general title of captain.

The duties of colonels formerly are described in Ward's 'Animadversions of Warre,' which was published in 1639. The colonelcy of a regiment is now an honorary title carrying a certain emolument with it. See 'Hart's Army List.' The colonels of regiments have little or nothing to do with the actual command of the regiment, but are generally general officers, who receive the colonelcy of a regiment either by seniority or for distinguished service. The emolument above referred to was derived formerly from the colonels providing the clothing of a regiment, and being allowed the difference between the price at which the contractor furnished the clothing and the sum allowed by government. This has now been changed to a fixed emolument, and the clothes are provided by government. Colonels take precedence of one another according to the dates of their commissions, and not according to the seniority of their regiments.

The lieutenant-colonel is in rank immediately under the full colonel. He has the whole command of the regiment, and is responsible for the drill and discipline.

The annual pay of a colonel is, in the Life Guards, 1800*l.*; in the Grenadier Guards, 1200*l.*; in the Coldstream and Scots Fusilier Guards, 1000*l.*; in the 1st Dragoon Guards, 1000*l.*; in the cavalry regiments generally, 900*l.*; and in the regular infantry, 500*l.* The daily pay of a lieutenant-colonel is, in the Life Guards, 1*l.* 9*s.* 2*d.*; in the Foot Guards, 1*l.* 6*s.* 9*d.*; and in the infantry, 17*s.* The price of a lieutenant-colonel's commission is, in the Foot Guards, 9000*l.*; in the Life and Horse Guards, 7250*l.*; in the Dragoons, 6175*l.*; and in the infantry of the line, 4500*l.* For further particulars of rates of pay, &c., see 'Hart's Army List,' pay tables.

COLONNADE, a general term for any range of columns supporting an architrave. The term peristyle is often applied in the same sense, yet somewhat inaccurately, since it denotes a range of columns continued quite round a building or court, as in a peripteral temple, the Town Hall at Birmingham, or the Bourse at Paris. The covered way at the Quadrant, Regent Street, was a good example of a colonnade; the most familiar existing examples are the colonnade at the Italian Opera House in the Haymarket, and the columned front of the British Museum.

CO'LONY (in Latin *colonia*, a word derived from the verb *colo*, *colere*, to till or cultivate the ground) originally signified a number of people transferred from one country or place to another, where lands were allotted to them. The people themselves were called Coloni, a word corresponding to our term colonists. The meaning of the word was extended to signify the country or place where colonists settled, and is now often applied to any settlement or land possessed by a sovereign state upon foreign soil. Thus Ceylon and the Mauritius are called British colonies, though they are not colonised by Englishmen, the former being inhabited by natives, and the second by French or descendants of French colonists. The proper notion of the word "colony" (as determined by the general use of the term) seems to be a tract of land, either wholly or partly colonised, that is to say, possessed and cultivated by natives, or the descendants of natives, of another country, and standing in some sort of political connection with and subordination to that country, which is then called the mother country.

The formation of colonies is among the oldest occurrences recorded in history or handed down by tradition. Maritime states, such as those of Phœnicia and of Greece, possessing only a scanty territory, would naturally have recourse to emigration as their population increased. In both these countries the sea afforded a facility for transferring a part of their superabundant citizens, with their families and moveables, and their arms, to some foreign coast, either uninhabited or thinly peopled by less-civilised natives, who, by good will or by force, gave up to them a portion of their land. The emigration might be voluntary or forced; it was no doubt in many cases the result of civil contentions or foreign conquest, by which the losing party were either driven away, or preferred seeking a new country to remaining at home. The report of some remote fertile coast abounding in valuable productions would decide others. Lastly, the state itself having discovered, by means of its merchants and mariners, some country to which they could trade with advantage, might determine upon sending out a party of settlers, and might establish a factory there for the purpose of sale or exchange. In fact, commercial enterprise seems to have led both to maritime discovery and to colonisation as much as any one single cause. Such seem to have been the causes of the numerous Phœnician colonies which, at a very early date, were planted along the coasts of the Mediterranean. Tyre itself was a colony of Sidon, according to the Old Testament, which calls it the "daughter of Sidon." Leptis Magna, near the great Syrtis, was also a colony of Sidon, according to Sallust ('Jugurth.' c. 78). Hippo, Hadrumetum, Utica, and Tunis, were Phœnician colonies, and all of greater antiquity than Carthage. The Phœnician colonies extended along the north coast of Africa as far as the Pillars of Hercules (the Straits), and along the opposite coast of Spain, as well as on the Balearic islands, and Sardinia and Sicily. Those on the Spanish coast seem to have been at first small settlements or factories for the purpose of trade between the metropolis or mother country and the natives. Several of them, however, such as Gades, by degrees took the trade into their own hands, and became independent of the mother country. The foundation of Carthage was an instance of another kind. It resulted, according to tradition, from an emigration occasioned by the tyranny of a king of Tyre. There is another confused tradition of a Phœnician or Canaanite emigration to Mauritania, occasioned by the conquest of Palestine by Joshua, and mentioned by Procopius and Suidas, as well as by some Jewish commentators. [BERBERS, GEOG. DIV.] The Phœnicians very early settled in the fertile island of Cyprus, which lay opposite their own coast. Of their settlements in the islands of the Ægean Sea we have only traditions referring to times previous to the war of Troy, and mentioned by Herodotus, and after him by Thucydides, who says that the Phœnicians and the Carians inhabited most of the islands, and carried on piracy, until Minos, king of Crete, drove them away, and planted new colonies. Herodotus says they had once a settlement in the island of Thasus, where they worked the gold mines. They also had a settlement on the island of Cythera (Cerigo), which lay conveniently for their trade with the Peloponnesus. Thucydides (vi. 2, &c.) also mentions that the Phœnicians formed establishments on the promontories and small islands on the coast of Sicily, from which they traded with the native Siculi; but that when the Greeks came to settle in great numbers in that island, the Phœnicians abandoned several of their posts, and concentrated themselves at Motya, Soloeis, and Panormus, now Palermo (which last probably had then another name), near the district occupied by the Elymi or Phrygian colonists (who had emigrated from Asia after the fall of Troy, and had built Entella and Egesta), trusting to the friendship of the latter, and also to their proximity by sea to their countrymen of Carthage. These three Phœnician settlements, however, merged afterwards into Carthaginian dependencies. The Phœnicians appear also to have occupied Melita or Malta, and the Lipari islands, one of which retained the name of Phœnicusa. Of the Phœnician settlements in the south part of Sardinia we have the report of Diodorus (v.) and a fragment of Cicero pro Scauro, published by Mai. The Phœnicians and Libyans are said to have been the earliest settlers in Sardinia, and to have founded Caralis (Cagliari) and Sulci. A Phœnician inscription was found in a vineyard at Cape Pula, belonging to the monks of the order of Mercy, and was explained by De Rossi, 'Effemeridi Letterarie di Roma,' 1774. But the undoubted field of Phœnician colonisation was the north coast of Africa. There the Phœnician settlements seem to have been independent, both of the mother country and of each other. We have the instance of Utica and Tunes, which continued separate communities even after Carthage had attained its great power; Carthage only exercising the hegemony or supremacy. This seems to have been the case among the original Phœnician towns; Sidon, Tyre, Aradus, &c., each a distinct commonwealth, forming a sort of federation, at the head of which was the principal city, at first Sidon, and afterwards Tyre. A feeling of mutual regard seems to have prevailed to the last between the various Phœnician towns and colonies, including Carthage, as members of one common family.

The colonies established afterwards by the Carthaginians in the interior as well as on the coast of Africa, Sicily, and Spain, were upon a different plan from those of the Phœnicians: they were made through conquest and for the purpose of keeping the country in subjection, like those of the ROMANS [CARTHAGE, GEOG. DIV.], with the remarkable exception of the emigration colonies taken by Hanno to the west coast of Africa.

The earlier Greek colonies appear to have owed their origin to the same causes, and to have been founded upon the same plan as those of the Phœnicians. Thucydides (i.) says, that "after the Trojan war, and the subsequent conquest of Peloponnesus by the Dorians, Greece being restored to tranquillity, began to send out colonies. The Athenians, whose country was overflowing with people from other parts of Greece, who had flocked thither for security, began to send out colonies into Ionia and to many of the islands; the Peloponnesians sent theirs to Italy, Sicily, and some parts of Greece. But all these colonies were sent after the Trojan war." The Dorians from Megaris, Argos, Corinth, and other places, colonised some of the larger islands, part of Creta, Rhodes, Corcyra, as well as Ægina, Cos, &c. They founded the Hexapolis on the south-west coast of Caria, in Asia Minor, which district took from them the name of Doris. A colony of Lacedæmonians founded Cyrene. The Megarians founded Chalcedon, Byzantium, Selymbria, Heraclea, and other places on the coasts of the Euxine. Sicily also was chiefly colonised by Dorians. Syracuse was a Corinthian colony, which afterwards founded Acræ, Camarina, &c., Gela was a colony of Rhodians and Cretans, and Agrigentum was a colony from Gela. The Megarians founded Selinus. The Chalcidians built Naxus, which was the first Greek settlement in Sicily, and afterwards took Leontini and Catana from the Siculi. For a more detailed account of the numerous Dorian colonies, see K. O. Müller's 'History of the Doric Race.'

The Ionians from Attica, another great branch of the Hellenic stock, after the death of Codrus, the last king of Athens, emigrated to the west coast of Asia Minor, which took its name from them and established there twelve cities or communities, which quickly rose to a high degree of prosperity, and formed a kind of federal union. About eighty years before, the Æolians and Achæans, two nearly allied races, being driven away from Peloponnesus by the Dorians, had emigrated to the coast of Asia Minor, where they formed colonies from Cyzicus on the Propontis as far southwards as the Hermus. Phocæa was the most northern of the Ionian towns on the borders of Æolis. The Æolians also colonised the islands of Lesbos, Tenedos, and others in that part of the Ægean. These emigrations were posterior to the time of Homer, who mentions other people as occupying that coast. The Athenians at a later date colonised Eubœa, where they founded Chalcis and Eretria, and they also sent colonies to Naxos, to the islands of Ceos, Siphnos, Seriphos, and other islands of the Ægean. Many of these colonies having thriven and increased, became colonisers in their turn. The enterprising mariners of Phocæa formed various colonies, the most celebrated of which is Massilia on the south coast of Gaul. The Chalcidians of Eubœa founded Cumæ, on the west coast of Italy, in the country of the Opici. Pirates from Cumæ founded Zancle, but a fresh colony of Samians and other Ionians escaping from the Persian invasion, in the time of the first Darius, took Zancle, and were afterwards in their turn dispossessed by Anaxilas, tyrant of Rhegium, who called the town Messene (now Messina), from the name of his original country in the Peloponnesus. The Æolians founded Dicæarchia, afterwards Puteoli, and they with the Cumæans are believed to have founded Parthenope (Naples). Ionian colonists settled on the coast of Sardinia.

The Greek colonies on the east coast of Italy, setting aside the confused traditions of Arcadian immigrations, Pelasgian, &c., supposed to have taken place before the Trojan war, consisted chiefly of Dorians and Achæans from the Peloponnesus. Croton, Sybaris, and Pandosia were colonies of the latter. Tarentum was a colony of Lacedæmonians, and Locri Epizephyrii of the Locrians. Greek colonies were settled both on the north and east sides of the Pontus (Black Sea), and also on the north coast in the modern Crimea. [Bosporus, in Geog. Div.]

As to the relations subsisting between the colonists and the natives or prior inhabitants of the countries which they occupied, it was undoubtedly in most cases strictly in accordance with the right of the strongest. Either the natives withdrew into the interior and left the ground to the new occupants, as the Siculi did in several instances, or they resisted, in which case, when overpowered, the men were exterminated or reduced to slavery, and the conquerors kept the women for themselves. In some instances the older inhabitants were reduced to the condition of serfs or bondmen to the new settlers. The records of authentic history do not present us with an instance of any colony being settled in a country where there were not previous inhabitants. The consequence of the immigration of a new race, who seek to possess themselves of the land, must be the extermination or gradual decay of the prior race, unless the old inhabitants are made slaves. So far as we trace the history of Greek colonies in the scattered fragments of antiquity, such were the consequences of their colonial settlements. On the coast of Italy it would appear that the Greeks pursued a more humane or more politic course. They are said to have allied themselves to and intermarried with the natives, and by their superior civilisation to have acquired great influence. It may here be remarked that the Greeks, so far from being averse to foreign intermixtures, as some have said, mingled their blood freely with that of all the nations with whom they came into contact, and thus the civilisation of the Hellenic stock was gradually introduced among nations less advanced in the useful arts.

What were the relations between these Greek colonies and the mother country, and between those colonies that were of a kindred race?

This may be gathered pretty clearly from Thucydides. Epidamnus was a colony of Corcyra; but the leader of the colony (*οἰκιστής*), the founder of the colony, or the person under whose conduct it was settled, was a Corinthian, who was called or invited, says Thucydides, from the mother city (called by the Greeks the metropolis, *μητρόπολις*, or parent state), according to an ancient usage. Thus it appears that if a colony wished to send out a new colony, this was properly done with the sanction of the metropolis. Some Corinthians and other Dorians joined in the settlement of Epidamnus, which became a thriving community, and governed itself independently of both mother countries. In the course of time, however, civil dissensions and attacks from the neighbouring barbarians induced the Epidamnians to apply to Corcyra, as their metropolis, for assistance, but their prayers were not attended to. Being hard pressed by the enemy, they turned themselves to the Corinthians, and gave up their town to them, as being the real founders of the colony, in order to save themselves from destruction. The Corinthians accepted the surrender, and sent a fresh colony to Epidamnus, giving notice that all the new settlers should be on an equal footing with the old settlers: those who did not choose to leave home were allowed to have an equal interest in the colony with those who went out, by paying down a sum of money, which appears to have been the price of allotments of land. Those who went out gave their services; those who stayed at home gave their money. "Those who went out," says Thucydides, "were many, and those who paid down their money were also many." For the moneyed people it was in fact an affair of pure speculation. The Corcyræans, themselves originally a colony from Corinth, having become very powerful by sea, slighted their metropolis, and "did not pay to the Corinthians the customary honours and deference in the public solemnities and sacrifices, as the other colonies were wont to pay to the mother country." They accordingly took offence at the Corinthians accepting the surrender of Epidamnus, and the result was a war between Corcyra and Corinth. (i. 24.)

Again, the Corcyræan deputies, who were sent to court the alliance of the Athenians against Corinth, stated, in answer to the objection that they were a colony of Corinth, that "a colony ought to respect the mother country as long as the latter deals justly and kindly by it; but if the colony be injured and wrongly used by the mother country, then the tie is broken, and they become alienated from each other, because, said the Corcyræans, colonists are not sent out as subjects, but as free men having equal rights with those who remain at home." (i. 34.) This shows the kind of relation as understood by the Greeks between the metropolis and its colonies. The colonies were in fact sovereign states, attached to the mother country by ties of sympathy and common descent, so long as those feelings were fostered by mutual good-will, but no further. The Athenians, it is true, in the height of their power, exacted money from their own colonies as well as from the colonies of other people, and punished severely those who swerved from their alliance, such as Naxos; but this was not in consequence of any original right of dominion as supposed to belong to the mother country over the colony. Many of the colonies, especially the earlier ones, which were the consequence of civil war or foreign invasion, were formed by large parties of men under some bold leader, without any formal consent being asked from the rest of the community: they took their families, their arms, and their moveables with them, to conquer a new country for themselves; they left their native soil for ever, and carried with them no obligations or ties. Those that went off in more peaceful times, by a common understanding of the whole commonwealth, went also away for ever, and freely and voluntarily, though under a leader appointed by the parent state, to seek a country where they could find an easier subsistence than at home. In either case it was a complete separation of a member from the body. When the Athenians, in later times, took possession of parts of Eubœa (Thucyd. i. 114), and of Ægina (ii. 27), of Melos (v. 116), and shared the lands among their own citizens who went there, the relationship thus formed was of a different kind. In the case of Ægina the whole population, which was of Hellenic stock, was turned out, and a body of Athenians occupied their place, with the express object of being as a body or community subordinate to the state of Attica, in order to prevent the annoyance to which Attica had long been subject by the proximity of an independent island so well situated both for the purpose of annoying Attica and for self-defence.

That the colonies of a kindred race should feel a common interest in opposition to those of a rival branch is natural, and is proved among other instances by the case of the deputies from Egesta in Sicily, who, while requesting the assistance of the Athenians against the Syracusans and Selinuntians, urged as an additional plea that the Leontines, who were originally Chalcidians, and therefore akin to the Athenians, had been expelled from their town by the Syracusans, and showing that it was the interest of the Athenians to assist a kindred people against the prevailing power of the Dorian colonies in Sicily. (Thucyd. vi.)

Before we pass to the Roman colonies, we must say something of the system of colonisation among the other inhabitants of the Italian peninsula in the ante-Roman times. The Etruscans extended their conquests north of the Apennines in the great plain of the Po, and founded there twelve colonies, the principal of which was Felsina (Bologna). They afterwards, having defeated the Umbrians, many years before the assumed foundation of Rome, extended themselves into East and South Italy, penetrated into Latium, and took Campania from the Oscans, where they founded likewise twelve colonies, the principal of which was Capua. The Etruscans, being skilled in architecture, surrounded their towns with solid walls built of massive stones without any cement; they were also well versed in agriculture and hydraulics, and several of the earliest drains and canals in the Delta of the Po are attributed to them. They subjected, but at the same time necessarily civilised, the people among whom they settled. Their colonies seem to have formed independent communities, though allied by a kind of federation. The Etruscans also founded colonies in the Picenum, such as Hatria [Atri, in Geog. Div.], and Cupra Montana and Cupra Maritima. They took from the Ligures the country around the gulf now called Della Spezia, and founded the city of Luna. They likewise sent colonies to the islands of Elba and Corsica, for the Etruscans were a commercial as well as an agricultural people; they navigated the sea, and in the sixth century before Christ they defeated the Phocæans, and drove them out of Corsica. The Etruscans civilised Italy by means of their colonies; but, unlike Rome, they did not keep them united under a central power.

The Sabini, an agricultural and pastoral people, living in a mountainous country, sent colonies in very remote times to other parts of Italy. It was their custom, after the lapse of a certain number of years, to celebrate solemn sacrifices in the spring season, and to consecrate to the gods a number of young men, who were to quit their native land, and proceed under the auspices of Heaven to seek a new country. In this manner the Piceni and the Samnites are said to have been colonies of the Sabini. The Samnites in their turn sent out other colonies, and the Lucanians were one of these. The Samnites as well as the Sabini were entirely given to agricultural pursuits.

Rome, in the earliest ages of the republic, adopted the system of sending out colonies to the conquered countries. But the Roman colonies were different from those of most other people, inasmuch as they remained strictly subject to the mother country, whose authority they were the means of enforcing upon the conquered nations. They were, in fact, like so many garrisons or outposts of Rome. Servius (Æn. i. 12) gives the following definitions of a colony, taken from much older authorities: "A colony is a society of men led in one body to a fixed place, furnished with dwellings given to them under certain conditions and regulations." Again, "Colonia is so called a colendo; it consists of a portion of citizens or confederates sent out to form a community elsewhere by a decree of their state, or with the general consent of the people from whom they are departed. Those who leave without such a consent, but in consequence of civil dissensions, are not colonies." The notion of a Roman colony seems to be this: the colonists occupied a city already existing; and this, with perhaps one exception or two, was the general character of the Roman colonies in Italy Proper. When the Romans afterwards extended their conquests into countries where there were no regular towns, or where the population being fierce and hostile, the Roman settlers must be ever on their guard against them, they built new towns in some favourable position. Such was the case in several parts of Gaul, Germany, Dacia, &c. But the Roman colonies in Italy consisted of Roman citizens, who were sent as settlers to fortified towns taken in war, with land assigned to them at the rate of two jugera of arable land or plantation for each man, besides the right of pasture on the public or common land. The old inhabitants were not ejected, or dispossessed of all their property; the general rule was, that one-third of the territory of the town was confiscated and distributed among the colonists, and the rest was left to the former owners, probably subject to some charges in the shape of taxes or services. The colonists constituted the *populus* of the place; they alone enjoyed political rights and managed all public offices, the old inhabitants being considered as the plebs. The ownership of the publicum or public property, including the pasture land, was probably also vested in the new settlers. It is natural to suppose that for some generations at least, no great sympathy existed between the old and the new inhabitants, and hence we frequently hear of revolts of the colonies, which means, not of the colonists against the mother city, but of the old inhabitants, who rose upon and expelled the colonists. But these events generally ended by a second conquest of the place by Roman troops, when the old inhabitants were either put to the sword or sold as slaves, or, under more favourable circumstances, lost at least another third of their property. In later times, during the civil wars of Rome, new colonies were sent by the prevailing party to occupy the place of the former ones; and the older colonists were then dispossessed of their property, either wholly or in part, just as they had dispossessed the original inhabitants. Hence the saying, "Veteres migrate coloni." Sometimes colonies, especially at a great distance from Rome, having dwindled away, or being in danger from the neighbouring populations, asked for a reinforcement, when a fresh colony was sent, to whom the old colonists gave up one-third of their property. Each of the older colonies, it is observed by Gellius (xvi. 13), was a Rome in miniature; it had its senators called Decuriones, its Duumviri, Ædiles, Censores, Sacerdotes, Augurs, &c.

A distinction must here be made between the Roman colonies and the Latin colonies. The former had all or nearly all the rights of the citizens of Rome, although Sigonius and some others pretend that they had not the jus suffragii; and yet, in various passages of Livy and others, colonists are styled cives and Romæ censi. The Latin colonies had not the jus Quiritium, but only the jus Latii. All those, however, who filled magistrates' offices in Latin colonies became Roman citizens. Such was the case with Tibur, Præneste, &c. The towns of Transpadane Gaul, as a reward for their fidelity to Rome, obtained the rank of Latin colonies without any colonists being sent to them.

There were also military colonies, which consisted of soldiers, to whom land was given instead of pay and provisions, as a resting-place after their campaigns. Sulla appears to have been the founder of these, and Cæsar and Augustus added greatly to their number. These colonies are distinguished by having military ensigns on their coins, while the Coloniæ Togatæ, or citizen colonies, have a plough on theirs. (Heinecc. 'Antiqu. Roman. Syntagma.') The coins of some colonies have both marks, which means that the original colony consisted of citizens, after which a second was sent, composed of military. In Tacitus ('Annal.' i.) the veterans complain that, after their long service, they were rewarded only with uncultivated lands, situated in the neighbourhood of the enemies of the empire.

The system of colonies adopted by Rome had a double political object,—to secure the conquered countries, and to satisfy in part the claims of its own poorer citizens, and to get rid of turbulent characters. The importance of the Roman colonies to the empire is well expressed by Cicero, who calls them "propugnacula imperii et specula populi Romani." Such they doubtless were, and at the same time they were the germ of the civilisation of Northern and Western Europe. A nation of civilised conquerors, whatever evils it may inflict to gratify its own cupidity, confers on the conquered people unintentionally still greater benefits. By their colonies in Spain, Gaul, on the banks of the Rhine, and in Britain, the Romans established their language and their system of administration. The imprint of their empire is indelibly fixed on the existing nations of Europe.

The difference between Colonia and Municipium is, that the latter was a town of which the inhabitants, being friendly to Rome, were left in undisturbed possession of their property and their local laws and political rights, and obtained moreover the Roman citizenship, either with or without the right of suffrage; for there were several descriptions of Municipia. [Municipium.] The colonies, on the contrary, were all governed according to the Roman laws. The municipia were foreign limbs engrafted on the Roman stock, while the colonies were branches of that stock transported to a foreign soil.

Under the later Roman emperors, the difference between colonia and municipia became obliterated, and all were governed alike according to the Roman law, and a uniform system of administration. Augustus gave the right of Roman citizenship to all Italy. Antoninus Caracalla bestowed it upon all freemen, subjects of the empire. (For the Roman colonies, see Niebuhr, vol. ii.; Manutius, 'de Civitate Romana;' Sigonius, 'de Ant. Jure Ital.;' Heineccius, 'Syntagma,' &c.)

The northern tribes who overthrew the western empire did not found colonies; they overran or conquered whole provinces, and established new states and kingdoms. The same may be said of the Saracen conquests in Asia and Africa. But, after a lapse of several centuries, when Europe had resumed a more settled form, the system of colonisation was revived by three maritime Italian republics, Pisa, Genoa, and Venice. Their first settlements on the coasts of the Levant and Egypt were mercantile factories, which the insecurity of the country soon induced them to convert into forts with garrisons,—in short, into real colonies. The Genoese established colonies at Famagosta in Cyprus; at Pera and Galata, opposite to Constantinople; at Caffa in the Crimea, founded in 1266. They also acquired possession of a considerable extent of coast in that peninsula, forming a district subject to Genoa under the name of Gazaria. Another tract, on the coast of Little Tartary, called Gozia, was also subject to the Genoese, who had then the colony of Cembalo. In the Palus Mæotis they had the colony of La Tana, now Azof. On the south coast of the Euxine they possessed Samastro or Amastri. They had also a factory with franchises and their own magistrates at Trebizond, as well as at Sebastopolis. These colonies were governed by consuls sent from Genoa, and the order and justice of their administration have been much extolled. In the archives of St. George, at Genoa, there is a valuable unpublished manuscript containing the whole colonial legislation of the Genoese in the middle ages.

The Pisans, having taken Sardinia from the Moors, sent colonies to Cagliari and other places. Their settlements in the Levant were mere commercial factories.

The Venetians established colonies in the Ionian Islands, Candia, and Cyprus. Their system resembled that of Rome: they ruled, by means of their colonies and garrisons, over the people of those islands, whom they left in possession of their municipal laws and franchises. These were not like the settlements of the Genoese, merely commercial establishments—they were for conquest and dominion; in fact, Candia and Cyprus were styled kingdoms subject to the republic. The Venetians had also at one time factories and garrisons on various points of the coasts of the Levant, but they lost them in the Morea, Eubœa, Syria, and the Euxine, either through the Genoese, or afterwards by the arms of the Ottomans. We can hardly number among their colonies the few strongholds they once possessed on the coast of Albania, such as Butrinto, Prevesa, Parga, &c., any more than those possessed by the Spaniards and Portuguese on the coast of Barbary, Oran, Melilla, Ceuta, &c. They were merely forts with small garrisons, with no land attached to them. The name used in the Mediterranean for such places is presidii, and they are often used as prisons for criminals.

The discovery of America produced a great change in the system of colonisation. Hitherto, whether the colony had been planted by force or by treaty, the colonists on the whole were not greatly advanced in civilisation beyond the original possessors; and whether they reduced them to subjection or amalgamated with them, there was no essential difference of race; for even the early colonies of the Portuguese in Africa were either at places inhabited by the civilised Arabs, or in spots where they merely planted a military garrison to defend their trade. The Spaniards were the first who established colonies in America, and they were rapidly followed by nearly every European nation. But among these nations there was a great variety in the manner of the acquisition, the objects sought to be attained, and the mode of government in the colonies, both locally and with reference to that of the mother country. It soon became evident that not all nations were equally qualified to become successful colonists; to be so appears to require in the colonists, capital, superior knowledge and intelligence, industry, and firm resolution. The Spaniards, landing among the semi-civilised nations of South America, possessed the superior intelligence and the unconquerable resolution. They succeeded in subduing the natives; but they brought no capital, and they evinced no industry. From the beginning, they sought only to enrich themselves and their country by despoiling the natives, and by forcing them to work, while the commerce of the settlement was obstructed by burdensome and injurious restrictions. The consequence has been that the population, becoming a mixed one, treated as inferiors by the new Spanish accessions, and feeling their own strength, have thrown off their allegiance.

An essential qualification of a colony is that it should have and cultivate land, and consist at least in part of civilians. When a colony is sent to a country occupied by a few hunting tribes, as was the case in part of North America at the time the English settled there, and as was also the case in Australia, the taking possession of part of the land for the purpose of cultivation is attended with the least possible injury to the aborigines, while, at the same time, it has in its favour the extension of civilisation upon a new shore. The savages generally recede before civilised man; a few of them adopt civilisation, and the rest become gradually extinct. When the limits are confined, the progress towards extinction is exceedingly rapid. The aborigines of Van Diemen's Land are now reduced to a very small number. This, however melancholy in one point of view, has been from the earliest times the great law of the progress of the human race. But the case is much altered when the natives are partly civilised, live in domestic societies, have settled habitations, and either cultivate the land or feed their flocks upon it. The colonists in such case do what the Romans did in their colonies; they take part of the arable land, or the whole of the common or pasture land, and leave to the natives just what they please, and if the latter resist, they kill them. Whether this be justice every man may ask himself. The case may be one of greater or less oppression, according as the land is either enclosed and cultivated, or merely used for pasture or the chace, and according as the natives are more or less numerous in proportion to the land, colonisation may proceed on a milder or harsher system. Still the question of justice remains the same, unless the natives be willing to part with their land by amicable arrangement. This system of purchase from the natives has been practised both by the English and Anglo-Americans in North America; but though it has the specious name of bargain, it has often been nothing more than a fraud, or sale under compulsion. The man of Europe has been long accustomed to regard the possession of the soil as that which binds him to a place, and gives him the most secure and least doubtful kind of property. His habits of accumulation, and of transmitting to his children a permanent possession, make him covet the acquisition of land. In whatever country he has set his foot, and once got a dominion in the soil, neither contracts, nor mercy, nor feelings of humanity, nor the religion which he carries with him, have prevented him from seizing on the lands of the owners, and punishing their resistance with death.

When the Portuguese first began their voyages of discovery in the 15th century, they took possession of some islands or points on the coasts of Africa and of India, and left there a few soldiers or sailors under a military commander, who built a fort to protect the trade with the natives, and afterwards also to keep those natives under a sort of subjection. In Brazil, settling among a people who were less advanced in civilisation than the Mexicans and Peruvians, and inhabited a country less densely populated, they effected their colonisation somewhat more peacefully, and maintained their empire with much less harshness. Brazil having no gold or silver (or none of much value), and the diamond mines occupying but a small space, the forced labour when employed was chiefly agricultural, and therefore less injurious. The agriculture produced commerce, and these united brought a considerable number of settlers; but the commerce was of a restrictive character, and the native Portuguese were a privileged class. The natives, to a considerable extent, remained roving and independent; the colonial population, confined to a few ports and the surrounding districts, where sugar, coffee, tobacco, and a few other products are grown, became discontented; and had not the political circumstances of Europe compelled the royal family of Portugal to retire to Brazil, it is probable the colony would have revolted. By that step, however, the colony became an empire; the misgovernment by foreigners ceased, a more enlightened system of commerce was adopted, and it has since grown rapidly in wealth and importance: but it has ceased to be a colony of Portugal.

The Dutch, with far higher qualifications for colonising than the Spaniards, followed almost a like system in their conquests of the Cape of Good Hope, the Moluccas, and in Java; but their object was to increase and to monopolise their trade. To this purpose all their efforts were directed, and for a time they succeeded to a considerable extent, but they did not attempt to draw any direct revenue from their dependencies. Powerful rivalry, however, and the dissatisfaction occasioned by the restrictions, altogether deprived them of some of their best colonies, and lessened the value of the remainder.

The French colonised Canada, and on the whole in a humane manner. But though in their relations with the natives they were not very successful in establishing themselves, they made the colonies too much of military settlements, and the civil colonial population increased very slowly. They kept troops and they raised fortifications, and both proved useless when put to the test; Louisiana they bought of Spain, made little progress in it, and sold it to the United States.

The English colonies have been acquired in almost every possible variety of manner: by settlement, by conquest, by treaty, by exchange. The North American colonies were the consequence of emigration, either voluntary or produced by religious persecution and civil war at home. The Puritans went to New England, the Quakers to Pennsylvania, and the Cavaliers to Virginia. They formed communities under charters from the crown, and had local legislatures, but were still subject to the sovereignty of the mother country. The mother country sent its governors, and named, either directly or indirectly, the civil functionaries. The precise amount of obedience that the colonies then owed to the mother country cannot be exactly defined. The American revolution only showed that it did not extend to a certain point, without showing how far it did extend. Australia was found almost a desert, and with the exception of a few incidental combats was peacefully settled. The Cape of Good Hope was taken from the Dutch; Jamaica and other West India islands from the Spaniards, French, and Dutch. The East Indies (which, however, is scarcely a colony, for until within the last few years Englishmen were not allowed to settle in it) has been obtained by treaty, by conquest, by succession, in an almost continued growth, without any violent desire for acquisitions, but from an impulse of self-preservation. The colonies have, as a general rule, local legislatures, elected by the people, and a governor and council named by the sovereign. The foreign commerce of these colonies is regulated by the sovereign authority of the mother country, and put on such a footing as generally to allow some of their products admission into British ports on more favourable terms than those of other countries. To the amount of this protecting duty, the colonies have the advantage of a partial monopoly in the markets of the mother country. The old strict colonial system, of excluding foreign countries from direct commercial intercourse with the colonies, had the double object in view of securing all the supposed advantages of the exchange of British for colonial products, and giving employment to the British merchant navy. The rigour of this system however has gradually relaxed, and given way to clearer views of self-interest. Still the colonial system, as maintained by Great Britain, presents in many instances examples of foreign possessions which are expensive to the country without any apparent corresponding advantages. The expenditure in most of the colonies for the purposes of administration and protection is beyond the means of the colonial revenues to meet, and the deficiency must of course be supplied by the parent state. That this is no trifle may be seen from the returns of the costs of the various British colonies for 1858. The total was 4,115,757*l.*, exclusive of the East Indies, and that was a less sum than in any of three previous years; and although a few may be considered rather as military or naval stations, yet the items show that none of the colonies are self-supporting, though many are large contributors to their own expenses. Gibraltar cost 423,589*l.*; Malta, 442,722*l.*; Cape of Good Hope, 682,015*l.*; Mauritius, 74,881*l.*; Bermuda, 158,061*l.*; St. Helena, 62,640*l.*; Heligoland, 1274*l.*; Ionian Islands, 199,470*l.*; Falkland Islands, 6523*l.*; and Hong-Kong, 303,735*l.*; the foregoing are all more or less military or naval stations. Of the Australian settlements, North Australia cost 5666*l.*; Western Australia, 94,769*l.*; South Australia, 9940*l.*; Victoria, 44,113*l.*; New South Wales, 59,646*l.*: Tasmania, 96,936*l.*; and New Zealand, 112,395*l.* Of the other plantations and settlements, Jamaica cost 193,711*l.*; Bahamas, 52,045*l.*; Honduras, 33,802*l.*; West Indies, 805,981*l.*; Canada, 236,484*l.*; Nova Scotia, 154,605*l.*; New Brunswick, 9430*l.*; Prince Edward's Island, 1500*l.*; Newfoundland, 20,114*l.*; Vancouver's Island, 210*l.*; West Coast of Africa, 126,039*l.*; Ceylon, 119,279*l.*; Labuan, 12,445*l.*: and sundry other colonies, 71,737*l.* The immense patronage which colonial possessions put at the disposal of the government is naturally one reason why colonies are looked upon as profitable things by those who participate in the advantages of posts and places in them. On the other hand, those who only contribute to these expenses may not unreasonably ask for some proof of solid advantage to the nation in return for this annual outlay. Setting aside the interests of those concerned in the administration of the colonies, it is asked, in many cases, what advantage does the rest of the nation receive? So far as colonies may be desirable posts for protecting British commerce and shipping, the advantage of maintaining them may be fully equivalent to the expense; and the settlement and protection of a colony by the natives of one country cannot fail to introduce the customs, the habits, and the wants of the country whence they come, which, consequently, will be in the best position for acquiring and maintaining possession of the commercial intercourse as it grows; this has been remarkably the case in regard to Canada, Australia, and the Cape. It is hardly possible to suppose that if they had been abandoned as too costly, the commerce would have assumed the vast importance which it has done. The protection of the mother country also gives a sense of security to intending emigrants, and the emigration is facilitated; it affords a most beneficial outlet to a superabundant population, removing a source of weakness and expense at home by the voluntary transfer of labour-power from where it has no value to a spot where it is of the greatest value; and, while it relieves the mother-country from a burden, it necessarily strengthens the bond of alliance, and contributes to the commercial prosperity of both parent and colony. Another prospective advantage is, the friendly relations that must necessarily exist from blood relationship, similarity of customs and feelings, and sameness of language, when the time arrives that the colony has grown powerful enough to maintain its own independence, and to assume the character of a state. Still, in every particular instance, the question as to the value of a modern colony to the mother country (omitting, as before mentioned, the value of the patronage to those who confer places in the colonies and the value of the places to those who receive them) is simply this: what advantage is this said colony to the productive classes of the country, and to those who consume the products of the colony? a question not always easy to answer; but this is the question, the solution of which must decide whether a colony ought to be maintained or not, if we look only to the interests of the mother country. If we look to the interests of the colony, it may be in many and certainly is in some cases, the interest of the colony to remain as it now is, under the protection and sovereign authority of the mother country. But again the question recurs, what is the advantage to the mother country? If some advantage cannot be shown, the maintenance of a useless colony is a pure act of national benevolence towards the colony and to those few of the mother country who have places in it. If our present relation with a colony such as Jamaica or Canada entails any expense on the mother country, we may ask whether all the commercial advantages that result from this relation would not be equally secured, if only the free commercial relation existed, and that of administration were to cease. In support of this view, it is shown that the commerce of Great Britain with the United States, now free and independent, has increased most wonderfully since the separation, and probably more rapidly than it would have increased under the colonial system. This being the case, a similar increase might be anticipated in the trade with all those foreign possessions whose trade is really of any importance. This argument, to which it is difficult to reply, is met by saying that if we give up those colonies that cause expenditure on the part of the mother country, some of them at least would be a prize for other nations, who would exclude us from the commerce of those former colonies, or allow it only on unfavourable terms; or that these colonies would throw themselves into the arms of foreign nations, and the same result would follow. To this it is replied, that no other nation is in a condition to take on itself the management of expensive colonies, especially when not in a condition to avail themselves to the fullest extent of the advantages of their commerce; nations, like individuals, will, if let alone, buy where they can buy cheapest, and sell where they can sell dearest. Spain, for instance, could derive no advantage from the possession of all Australia; she could draw no direct revenue from it; she could not use the colonial products, except the gold, which she could not buy, as she has no manufactures with which to effect the purchase.

The colonial administration of the British colonies is an important department of the general administration. At the head of it is the principal colonial secretary, who is one of the principal secretaries of state, assisted by two under secretaries.

A new feature was introduced into modern European colonisation, that of penal colonies, which was an extension of the principle of the presidii on the coast of Barbary, already mentioned. Convicts were sent by England first to North America, and afterwards to Australia and the Cape of Good Hope, by France to Guiana, by Portugal to the coast of Angola, by the Dutch to Batavia, and latterly by the French to Cayenne and to Lambessa in Africa. They were either employed at the public works or hired to settlers as servants, or were established in various places to cultivate a piece of land, for which they paid rent to the government. The policy of penal colonies has been much discussed. They may afford a relief at least temporary, but at a great cost to the mother country, by clearing it of a number of troublesome and dangerous characters, especially so long as criminal legislation and the system of prison discipline continue as imperfect as they are at present in most countries of Europe; but with regard to the convicts themselves, and the prospect of their reformation, everything must depend upon the regulations enforced in the colony by the local authorities. Although the system had its advantages as regarded the mother country, and perhaps as regarded the convict, yet the colonies as they increased in wealth and numbers, felt it to be an intolerable grievance to be continually flooded with the criminal refuse of the parent state. The system was opposed in the English colony at the Cape of Good Hope to the verge of an insurrection, but England gave way to the voice of justice, and on the remonstrances also of the Australian colonies, the system has been altogether abandoned, and only a few criminals are now sent to Western Australia, to Bermuda, and to Gibraltar, merely as to convict prisons, to be employed on public works.

We subjoin a list of the principal colonial possessions of the various European states; but of all the important ones accounts will be found under their proper heads in the GEOG. DIV.

The colonies of England consist of British North America, British West India Islands, with the Bahamas and Bermudas, and British Guiana in S. America; Sierra Leone, Cape Coast, and Cape of Good Hope in Africa; the islands of St. Helena, Mauritius, Ceylon, Prince of Wales Island, Singapore, and Malacca; various settlements on the coasts of Australia, and Tasmania, or Van Diemen's Land. The united population of the whole of these colonies is estimated at 7,148,000. The vast possessions of Great Britain in India, as we have already stated, are not to be considered as colonies, though they are dependencies; they contain a population of 180,367,148 persons. Gibraltar, Malta, and Heligoland, military stations, have a population of 146,591 persons.

France has the islands of Guadeloupe, St. Pierre, and Miguelon, and French Guiana in America; Senegal and Goree on the Coast of Africa; the island of Bourbon; Pondichery, in the East Indies, with two or three trifling dependencies; the Marquesas islands, New Caledonia, with Tahiti and Wallis islands, under protection, in the Pacific; and the important acquisition now being colonised to a considerable extent, of Algerie; the total has a population of 3,506,218, of which 2,880,383 are in Algerie, the European population in January, 1857, being 167,670.

Spain has lost her vast dominions in Mexico and South America, but has retained the fine islands of Cuba and Puerto Rico, and the Virgin islands in America; in Asia she has the Philippine islands; in Africa she has the Presidios and the Guinea islands, the old system still prevails; slave labour is employed; and the Spanish colonies are now perhaps the only ones that yield a direct revenue to the mother country; though it is probable that the United States makes a greater profit with them by its commerce, than Spain does by its taxation. The population of the whole of the colonial possessions is estimated at 4,528,633.

Portugal has lost the Brazils, but it has still numerous settlements on the coast of South and East Africa, at Angola, Benguela, Loango, and on the Mozambique; but these settlements are the most degenerated of all European colonies. In India the Portuguese retain Goa; they have a factory at Macao; and a settlement on the northern part of the island of Timor. The population is estimated at 2,756,379.

The Dutch have the islands of Curaçao and St. Eustache and Surinam in Guiana. In Asia they have the great colony of Batavia with its dependencies, various settlements on the coasts of Borneo, Sumatra, Celebes, Timor, and the Molucca islands. The population is estimated at 16,438,761.

The Danes are possessed of the islands of St. Cruz, St. John, and St. Thomas in the West Indies; and Christianburg, near Accra, on the Guinea coast; the population of the whole is only 37,187.

The Swedes have the island of St. Bartholomew in the West Indies; population about 18,000.

A society of North American philanthropists founded about 1821, on the Guinea coast, east of Cape Mesurado, a colony of emancipated negroes, who have been transferred thither from the United States. The colony is called Liberia. The total population, including natives, may be about 60,000.

COLOPHANE. [TURPENTINE.]

COLOPHENE. [TURPENTINE.]

COLOPHOLIC ACID. [RESIN.]

COLOPHONY. [RESIN.]

COLORINE. [MADDER, *Colouring Matters of.*]

COLOSSEUM. [AMPHITHEATRE.]

COLOSSIANS, EPISTLE TO THE, a canonical epistle of the New Testament, addressed by St. Paul to the Christians of Colossæ, a city of Phrygia. The date generally assigned to this epistle by the commentators and critics is A.D. 62. ('Tablettes Chronologiques,' par l'Abbé Lenglet Dufresnoy, tome ii. p. 211. Dr. Adam Clarke's 'Succession of Sacred Literature,' vol. i. p. 89.) Some say A.D. 63, or the 9th of Nero. In the Dissertations on the Harmony of the Gospels, by the Rev. Mr. Greswell (vol. ii. pp. 63–66), it is shown that the Epistles to the Ephesians, to the Philippians, and to Philemon, were written by St. Paul at the same time as the one to the Colossians, namely, in A.D. 60, nearly at the termination of the apostle's first imprisonment at Rome; and Epaphroditus in Philemon is considered by Mr. Greswell to be the same person as Epaphras in Colossians. There is a great similarity between this epistle and that to the Ephesians, the one being a commentary on the other, as Michaelis observes. From the expressions in ch. i. ver. 4, 7, 9, and ch. ii. 1, where he says, "for as many as have not seen my face in the flesh," it is inferred by some that St. Paul himself was personally unknown to the Christians of Colossæ; for though he travelled twice to Phrygia, it appears from Acts, chs. xvi. and xviii., that he visited the northern parts, while Colossæ was in the southern part. Others, especially Dr.

N. Lardner ('Credibility Gos.'), who argues on the statements of Theodoret (tom. iii. p. 342), assert that St. Paul preached and planted the church at this city. According to Eusebius, this city was one of three which, in the 10th year of Nero (that is, a year after the reception of this epistle), were totally destroyed by an earthquake. The chief object of St. Paul in this epistle appears to have been to exhort the Christians of Colossæ to adhere stedfastly to the doctrines which he taught, and to reject the opinions of the Jews and the Pagan philosophers. The concluding sentence of the fourth chapter states that the conveyance of this address was committed to Tychicus and Onesimus. (Eichhorn, Michaelis, Horne.)

COLOUR (in Optics). [Light.]

COLOUR (in Fine Arts). [Painting.]

COLOURING MATTERS. Each of the three great natural kingdoms, the animal, the vegetable, and the mineral, abound in substances the chief peculiarity of which is, that they possess colour. For the cause of this colour see the article Light; Colour. At present it will only be necessary to mention these colouring matters, classify them, state their general properties, and direct attention to the source whence more detailed information may be derived concerning them individually.

Colouring matters are either *organic* or *inorganic*, that is derived from organised bodies, such as animals or vegetables, or from unorganised substances, namely minerals. Organic colouring matters are usually more complex in composition, and more liable to alter in tint than the inorganic ones; indeed the latter are for the most part definite compounds of metals, while the former are often mixtures of several proximate principles, and have always a tendency to be decomposed into more simple forms of matter.

In addition to the colours that occur ready formed in nature, the study of chemistry has brought to light many artificial ones.

The great point of interest connected with colouring matters is the employment of them in the decorative arts. Scarcely one can be mentioned, provided it can be obtained at anything like reasonable cost, and is possessed of beauty and durability, which has not been employed by the calico-printer, paper-stainer, painter, &c.

For the sake of convenience the following colouring matters will be treated of without reference to their organic or inorganic origin, but will be grouped together according to their similarity in appearance.

Yellow Colouring Matters.

Arnotto. [Arnotto; Bixin; also Bixa, in Nat. Hist. Div.]

Chrome-yellow occurs in twenty shades, and under as many different names, each celebrated for its particular tint; thus prefixed to the word yellow we find, *Altenburg, Cahlaer, Citron, Cologne, Gotha, Leipsic, Paris, Zurickau, &c.* [Lead, *Chromate of.*]

Fustic or *yellow wood.* The wood of a tree. [Fustin; also Rhus-cotinus, in Nat. Hist. Div.]

Gamboge. [Gamboge; also Garcinia, in Nat. Hist. Div.]

Ochre occurs native in various shades, and is met with under the names of *yellow ochre, gold yellow, gold earth, gold ochre, yellow sienna, Chinese yellow.* It is composed of hydrated oxide of iron with alumina, lime, &c. [Ochre.]

Orpiment, auripigmentum, Persian or *king's yellow.* [Arsenic, *Sulphide of.*]

Persian berries, or *Avignon grains,* contain *chryso-rhamnin.* [Rhamnus infectorius, Nat. Hist. Div.]

Purree, or *Indian yellow.* [Purreic acid.]

Quercitron, the bark of a tree. [Quercitrin; also Quercus tinctoria, in Nat. Hist. Div.]

Rhubarb yellow. [Chrysophanic acid.]

Saffron, the internal part of a flower. [Saffranin; also Crocus sativus, in Nat. Hist. Div.]

Turmeric. The root of a tree. [Turmeric; Curcumin; also Curcuma longa, in Nat. Hist. Div.]

Weld. A dried plant. [Luteolin; also Reseda luteola, in Nat. Hist. Div.]

Chrome orange is, as the name implies, a colour between yellow and red. [Lead, *Dichromate of.*]

Red Colouring Matters.

Alkanet red, sometimes called *Schnap's violet.* A spirit colour prepared from the root of a tree. [Anchusic Acid; also Anchusa tinctoria, in Nat. Hist. Div.]

Brazil-wood lake occurs under the names of *Ball alke, Berlin red, Florentine lake, purple, pink* or *crimson lake,* and *washing red.* [Brazil-wood, *Colouring Matter of;* also Cæsalpinia, in Nat. Hist. Div.]

Cinnabar, or *Chinese red, vermilion,* and *Paris red.* [Mercury, *Sulphide of.*]

Chrome cinnabar, a very basic chromate of lead. [Lead, *Chromates of.*]

Cochineal, a dried insect. Prepared as a lake, it occurs under the name of *carmine.* Many terms, such as *Paris lake, Vienna lake,* &c., are applied indiscriminately to the colouring matters of Brazil wood and cochineal. [Carmine; also Coccidæ, and Cochineal, in Nat. Hist. Div.]

Garancin, prepared from madder. [Garancin.]

Madder, the root of a tree. [Madder, *Colouring Matters of;* also Rubia tinctorum, in Nat. Hist. Div.]

Red lead, minium, or *menuie.* [Lead, *Oxides of.*]

Red oxide of iron is found native. Its shades vary from a light to a brown-red. The common names of it are *Armenian bole, Berlin red, colcothar, English red, red ochre, burnt ochre, red earth, terra di sienna, mineral purple, stone red, Indian red.* [Iron, *Oxides of;* Ochre.]

Sandal wood, or Saunders' wood, furnishes what is called *violet saunders,* the wood of a tree. [Santalin; also Pterocarpus santalinus, in Nat. Hist. Div.]

Safflower, bastard saffron, dried flowers. [Carthamin; also Carthamus tinctorius, in Nat. Hist. Div.]

Lac-dye, very similar to cochineal. [Shell-lac.]

Logwood furnishes to acids a valuable red. [Hæmatoxylin; also Hæmatoxylon campeachianum, in Nat. Hist. Div.]

Red enamel colours, for glass-staining, &c., are *purple of cassius* [Gold], and *red oxide of copper.* [Copper, *Oxides of*].

Aloes also furnish a red colouring matter. [Chrysammic Acid.]

Blue Colouring Matters.

Cobalt blue, Thénard's, Hopfner's blue, cobaltic ultramarine, oxide of cobalt precipitated along with alumina or phosphate of lime. [Cobalt.] *Smalt, Saxon blue, King's blue,* a cobalt glass powdered. [Cobalt.]

Copper blue, mountain blue, English or *Hambro' blue.* [Copper, *Carbonate of.*]

Indigo is the base of several blue colours. [Indigo; Indigotin; also Indigofera, in Nat. Hist. Div.]

Lichen blue, litmus, turnsole, orchil or *archil,* and *cudbear,* are colours furnished by many lichens or liverworts. [See the respective names; also Lichens, *Colouring Matters of;* also Lichens, in Nat. Hist. Div.] [Blue.]

Prussian blue, Erlangen, Louisa, Saxon, Paris, or *Berlin blue.* [Iron, *Cyanides of.*]

Ultramarine, lapis lazuli, azure blue, Vienna, Meissner, and *Nuremberg ultramarine.* [Ultramarine.]

Glass and enamel are coloured blue with cobalt oxide.

Green Colouring Matters.

Arsenical greens occur under between forty and fifty different names, including *Brunswick, Scheele's* and *Schweinfurth green.* [Copper, *Acetate and Arsenite of.*]

Chlorophyll, or *leaf green,* from grass, leaves, &c. [Chlorophyll.]

Sap-green, buckthorn, vegetable, or *bladder green.* [Sap-Green; also Rhamnus, in Nat. Hist. Div.]

Blue and yellow are frequently mixed together to form green colours. Green ultramarine [Ultramarine] also bids fair to eclipse the arsenical greens.

Glass, porcelain, &c., are coloured green by oxide of chromium [Chromium] and oxide of copper. [Copper.]

Brown Colouring Matters.

Umber, sienna or *chesnut brown,* is found native. By heat it assumes a darker tint, and is then known as *burnt umber.* It is chiefly oxide of iron with silica and alumina. [Ochre.]

Sepia, a dried fluid contained in the cuttle-fish. [Sepia officinalis, in Nat. Hist. Div.]

Catechu, an extract prepared from the wood of a tree. [Catechu; also Acacia, Catechu, in Nat. Hist. Div.]

Black Colouring Matters.

Black lead, a crystalline form of carbon. [Graphite.]

Charcoal, under various forms. [Bone-Black; Lamp-Black.]

Burnt sugar is used to colour brandy, confectionery, and in the kitchen. [Caramel.]

Indian ink. [Ink.]

Black dyes are produced in many other ways, all having for their object the formation of tannate and gallate of iron.

White Pigments.

White lead, or *flake white.* [Lead, *Carbonate of.*]

Zinc white. [Zinc, *Carbonate of.*]

Chalk. [Calcium, *Carbonate of.*]

Plaster of Paris, or *gypsum.* [Calcium, *Sulphate of.*]

Heavy white. [Barium, *Sulphate of.*]

French chalk, or *talc.* [Steatite, in Nat. Hist. Div.]

Pearl white. [Bismuth, *Basic Nitrate of.*]

Starch alone is supposed to be used by confectioners as a diluent of the sugar, flavouring agent, and colouring matter.

Glass is rendered opaque white by oxides of tin and zinc, or by phosphate of lime.

In the arts and manufactures, all varieties of colours, tints, and shades are produced by mixing those already enumerated with each other.

Mauve is the name of a very delicate and beautiful purple or lilac colouring matter, recently discovered by Mr. Perkins. (Much of the *mauve* colour now seen is, however, obtained from *Archil* by a new process.) The colours produced by it are quite permanent. Its application to dyeing purposes has been patented. Mauve is so called on account of its colour being similar to that of the petals of the common mallow

(*Malva sylvestris*); mallow being rendered in French by the word *mauve*.

The colouring matters of flowers are owing, according to Fremy and Cloez, to two principles, *cyanine* and *xanthine*. The blue tints are produced by cyanine; the rose tints by cyanine in the presence of an acid. Xanthine furnishes the yellow shades, becoming brown in the presence of alkalies from formation of *xantheine*. [CYANINE, and XANTHINE.]

The dark *colouring matter of the eye* is said to be due to a substance called *melanine*. [MELANINE.]

Colouring matter of blood. [HÆMATOSIN.]

For the methods of fixing colours on fabrics, see DYEING and CALICO-PRINTING.

COLOURS. The word colour is used in many different ways. Besides its original meaning, in relation to the tints of rays of light, it has gradually come to be applied to the substances by which those tints are imitated.

Painter's colours, for house-painting and similar purposes, are mostly prepared from mineral substances (white lead, red lead, umber, ochre, &c.) ground up with linseed oil and turpentine to the state of a thick liquid. It would, perhaps, scarcely be supposed that 'Painters' Colours' appear in the Board of Trade tables, as an article of export, to the value of 150,000*l.* to 200,000*l.* annually.

The oil colours for artists are more carefully prepared than those for house-painting. They used to be sold tied up in small bladders; but an ingenious and more convenient arrangement is now adopted. Mr. Winsor's envelopes for colours, patented in 1840, consist of small metal or glass tubes, open at both ends, and provided with elastic pistons or plugs of cork or some similar material. The piston has a worm or nut in its centre, which corresponds to a screw attached to a handle rather larger than the tube. The open ends of the tube are covered with small metallic plates having holes in their centres. When the colour is placed in the tube, the arrangement of the apparatus is such as to keep the air from acting on it; and when any is required to be used, the screw is turned round, the piston is pressed down, and a little colour exudes from the lower end. These envelopes, like those of bladders, have however been superseded by a very ingenious contrivance, which has been generally adopted by artists, Mr. Rand's Collapsible Colour-tubes. These tubes were made the subject of a patent in 1842; the objects of which were to introduce a mode of punching out by dies the thin pieces of tin of which the tubes are made; and to make a screw cap at the mouth of the tube, to prevent leakage. These little tubes, by a gentle squeeze, are made to yield the colour at one end just in sufficient quantity for use.

Water-colours for artists include both vegetable and animal as well as mineral substances, and like the oil colours, are prepared with very great care. [COLOURING MATTERS.] They are prepared dry in cakes; in a slightly moist state in small cups of porcelain, gutta-percha, or tin; and in the collapsible tubes at first only used for oil-colours. From the care required in their preparation, water-colours of good quality were only obtainable at a comparatively high price, but the London Society of Arts has been instrumental in inducing manufacturers to produce shilling boxes of water colours applicable to the wants of students in schools of design, and other persons in humble life, of a character equal to those previously obtainable at a much higher rate.

Mr. Smith of Blackford communicated to the Royal Scottish Society of Arts, a paper showing that when chromate of lead is mixed with muriate of ammonia, and subjected to the action of heat, a substance is obtained of a different colour from either of the matters used. If the proportions of the substances be varied, and different degrees of heat applied, distinct colours and tints will be the result. Thus, when 5 parts of chromate of lead, and 1 part of muriate of ammonia are heated to redness in a crucible, a red colour is obtained; a blue colour is formed by heating 10 parts of muriate of ammonia, and 1 part of chromate of lead to ebullition; and a green is produced when the last mixture is heated nearly to redness. By employing various proportions of the substances, and different degrees of heat, a great variety of tints are formed—scarlet, orange, brown, blue, purple, green, yellow, and others. It is conceived by the discoverer that these properties may lead to useful applications in the arts.

The progress of chemistry naturally enlarges the list of substances from which colours can be obtained; and we find numerous patents bearing on this subject. A few years ago it was hoped that pigments for house-painters might be obtained from the residuum found in galvanic batteries, after the decomposition of those metallic compounds concerned in producing the galvanic action; the pigments are certainly produced, and batteries have been used expressly to this end; but the electro-colours, as they are called, have scarcely become a marketable commodity.

COLOURS ACCIDENTAL. [ACCIDENTAL COLOURS; LIGHT.]

COLOURS COMPLEMENTARY. [ACCIDENTAL COLOURS; LIGHT.]

COLOURS OF PLATES. [LIGHT.]

COLTSFOOT, the name given, owing to the shape of the leaves, to the compound indigenous plant, called by botanists *Tussilago Farfara*. Its Latin name has reference to its reputed virtues as a means of driving away coughs. If it be, as conjectured by Dr. Sibthorp and others, the Βήχιον of the Greeks, its fame descends from a very remote period; but its sensible properties do not seem to justify its character. The flowers and leaves are used in almost every way and means possible, both fresh and dry. The flowers are slightly odorous, and very slightly bitter, the leaves are more bitter; the latter somewhat mucilaginous. These when young, boiled, form a good spring vegetable, which might be more frequently used, especially by the poor.

No analysis (quantitative) of coltsfoot has been made, but the chief constituents are: mucilage, bitter extractive, tannic acid, colouring matter, salts, and woody fibre.

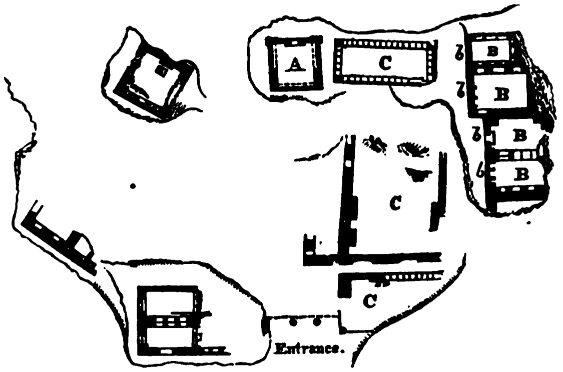
The properties are feebly tonic, demulcent, and emollient; on the latter account the leaves are sometimes used as an external application for poultices or fomentations. The vaunted properties of coltsfoot find no credence with the educated, and it only retains its reputation as a popular remedy. Hence it is chiefly sold as a *nostrum*, in the form of lozenges, which, when harmless, have their virtues increased by adding extract of liquorice and other demulcents, but which are often rendered hurtful and even destructive by morphia and other powerful narcotics. Essence of coltsfoot is a stimulating compound of balsam of tolu, compound tincture of benzoin, with a double quantity of rectified spirit of wine. Most improper at the beginning of colds, the root deserves attention as an astringent of considerable power.

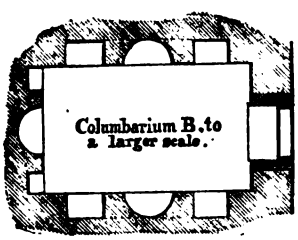
COLUMBA NO'ACHI (constellation), the dove of Noah, a constellation formed by Halley, close to the hinder feet of Canis Major. The following are the principal stars in this constellation :—

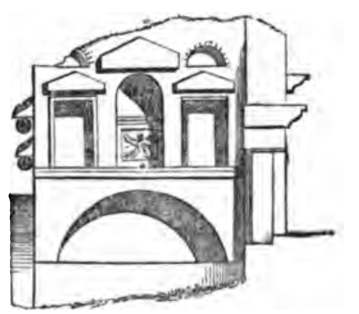
Character.	No. in Catalogue of British Association.	Magnitude.
ϵ	1739	4
α	1802	2
β	1878	3
γ	1922	4

COLUMBA'RIUM, a place of sepulture used for the ashes of the Romans after the custom of burning the dead had been introduced among them. It is usually a square or oblong room, the walls of which are pierced with small cells or niches for holding the urns which contained the ashes of bodies which had been subjected to burning. The word columbarium signifies a dovecote; and its application to the

Plan of Columbarium, discovered in the gardens of the Villa Doria Pamfili at Rome.







Section of Columbarium B.

Roman places of interment has arisen from the resemblance between the small arched holes which contain the sepulchral urns and the recesses formed for the doves in a dovecote.

This application of the word columbarium is proved by ancient inscriptions, but we are not aware that the term is used in this sense by any extant Latin writer.

In the Villa Doria Pamfili at Rome was discovered, in 1822, a very extensive columbarium, or rather an assemblage of columbaria, which are shown on the accompanying plan. It was surrounded by a wall, with a triple entrance, formed by two columns. The columbaria, which are on a very diminutive scale, are placed without any regularity. One building, A, superior in workmanship to the others, appears to have been a small temple in antis, built with red bricks, set with very delicate joints, and rubbed on the surfaces. The chambers, B, B, B, &c., were superior columbaria, with large niches, which contained double ollæ or vases for the ashes of the dead, with small tablets let into the wall below each niche. The small structures at C, C, which most resemble the dovecotes, are supposed to have been the sepulchres of the slaves. They are built with reticulated work, and are filled with several rows of pigeon-holes, which contain ollæ: they have no inscriptions. The brickwork of these columbaria is of several dates, if we may judge from the diversity of construction. The chambers B *b*, B *b*, have stone doorways, Egyptian in character. The interior of these little structures, and the temple, have been stuccoed and ornamented with reliefs, and painted. In the columbaria of wealthy families a considerable amount of decoration was sometimes expended. In the immediate neighbourhood of the Columbarium, in the Villa Doria Pamfili, are numerous inscriptions, tablets, and monumental urns, which belonged to these sepulchres, but having been removed from the ollæ, they lose part of their interest. There are several columbaria in the neighbourhood of Rome, among which that of the family Pompeia is remarkable for its tablets and urns. There is another and very fine sepulchral chamber, discovered in the year 1746, near the gate of San Sebastian at Rome.

COLUMBIN ($C_{22}H_{12}O_7$?), the supposed active principle of the Columba root. The root contains, according to Buchner—

Bitter substance with resin	12·2
Resinous colouring matter	5·0
Wax	·2
Gum	4·7
Starch	25·0
Pectin	17·4
Fibre	22·6
Water, salts, and loss	12·9
	100 0

Columbin is obtained from the alcoholic extract of the root, and crystallises therefrom during spontaneous evaporation. It is purified by filtering its alcoholic solution through animal charcoal, and it then possesses the following properties: It crystallises in bitter, inodorous, colourless rhombic prisms, possessing neither acid nor alkaline reaction. Boiling alcohol of ·835 dissolves from $\frac{1}{30}$ to $\frac{1}{40}$ of its weight. It is also soluble in caustic alkalies. Taken internally it is poisonous.

COLUMBIUM (Ta) *Tantalum.* A metal found in 1802, in two Swedish minerals, *tantalite* and *yttro-tantalite.* The first, somtimes called also *Columbite*, occurs amorphous and nodular, and also crystallised in the form of a right rhombic prism. The massive variety is either granular or compact: the crystals are grayish-black: fracture uneven; hardness, 6: sp. gr., 6·038; lustre, imperfect metallic; it is opaque. It contains about 80 per cent. of oxide of columbium, 12 of oxide of iron, and 8 of oxide of manganese. The yttro-tantalite contains oxide of columbium, *yttria*, and some other substances.

Columbium is obtained with great difficulty. Berzelius procured it by heating potassium with the potasso-fluoride of columbium. It is a black powder, which by the burnisher acquires the colour and lustre of iron. The specific gravity is about 6. It is nearly insoluble in acids. When heated in the air it is oxidised, and converted into columbic acid.

Oxygen and *Columbium* combine in two proportions, forming columbic acid and oxide of columbium.

Columbic acid may be obtained by burning the metal in the air; it is colourless, insipid, and does not act upon vegetable blue colours. When heated with charcoal it is reduced to the state of oxide. If heated with iron it loses oxygen, and an alloy of iron and columbium is formed. Columbic acid combined with water forms a very white hydrate, which reddens vegetable blues. It combines with salifiable bases to form salts which are called *columbates*, but no one of them is of any importance, or applied to any purpose whatever.

Columbic acid is composed of—

3 equivalents of oxygen	24
1 equivalent of columbium	185
Equivalent	209

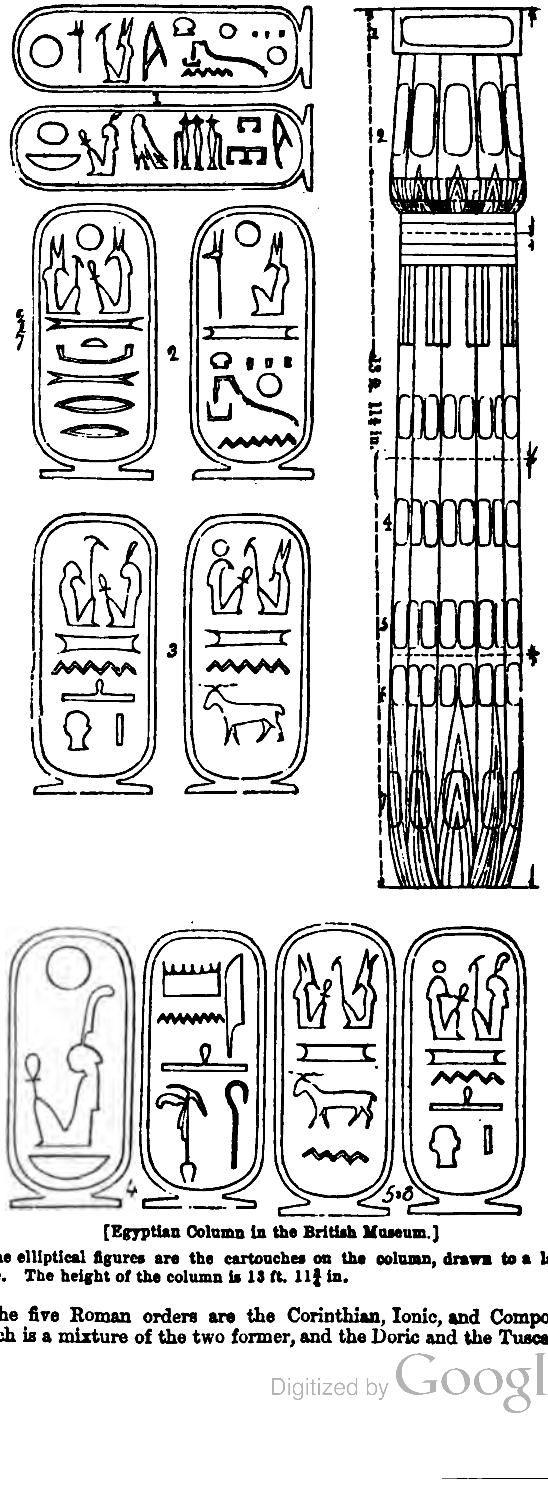
Oxide of Columbium is obtained by heating columbic acid to whiteness in a covered crucible. It is of a grayish black colour, very hard, and almost infusible.

Oxide of columbium consists of—

2 equivalents of oxygen	16
1 equivalent of columbium	185
Equivalent	201

Columbium combines also with chlorine and sulphur, &c., but these compounds are little known and of no importance.

COLUMN, from the Latin *columna.* The column is a shaft of wood, stone, or iron, in the form of a truncated cone, a little swelled from the straight line at about one-third its height from the lower extremity: this swelling is called the entasis. The column is furnished with a base at the foot and a capital at the head of the shaft. Columns are of various proportions and kinds: circular on the plan, and rarely polygonal. The Romans had five models of columns, which were called orders; but the Greeks, from whom the Romans appear to have derived their architecture, only three. The Egyptians used columns, but they were very different in their form and proportions from both the Roman and Greek examples. Very different again from all these were the columns in Assyrian architecture. [NINEVEH, ARCHITECTURE OF.]



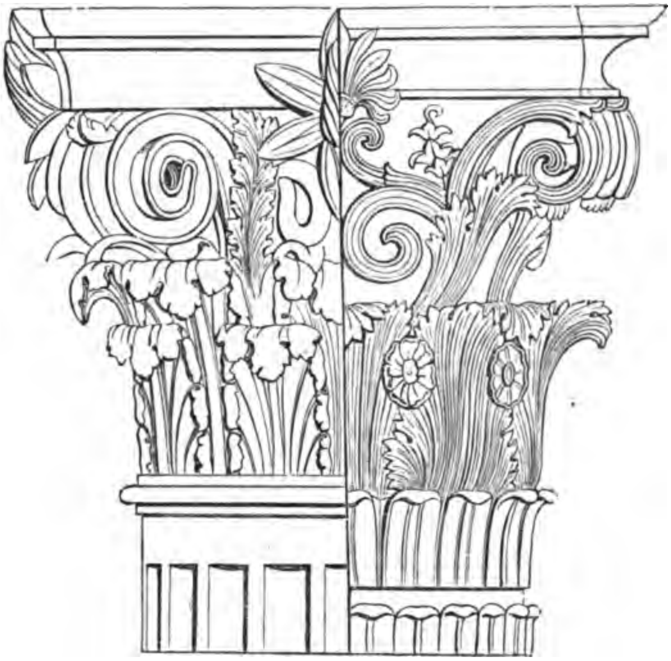
[Egyptian Column in the British Museum.]

The elliptical figures are the cartouches on the column, drawn to a larger scale. The height of the column is 13 ft. 11¾ in.

The five Roman orders are the Corinthian, Ionic, and Composite, which is a mixture of the two former, and the Doric and the Tuscan,—

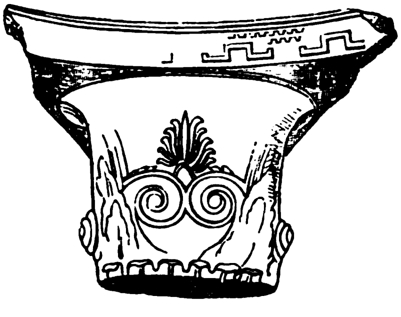
two orders very similar in appearance and character to each other. [ROMAN ARCHITECTURE.]

The Greek Corinthian, Doric, and Ionic differ from the Roman. The proportions of the orders vary slightly in almost every example of antiquity; but the distinguishing features are the capitals. The bases also vary in proportion, and sometimes in the profiles of their mouldings; but this is not so apparent to an ordinary observer as the difference in the capitals of the orders.

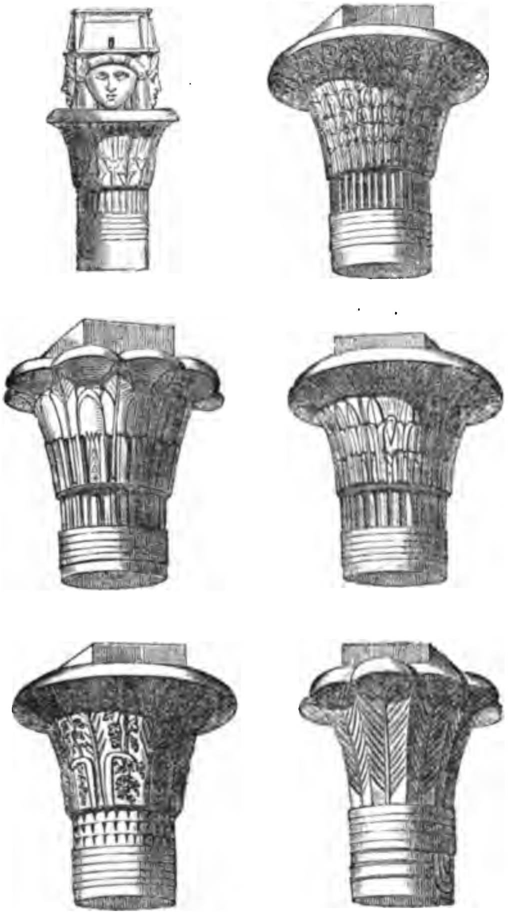


[Half the Corinthian capital of the Temple of Vesta, at Tivoli.] [Half the Corinthian capital from the monument of Lysicrates, at Athens.]

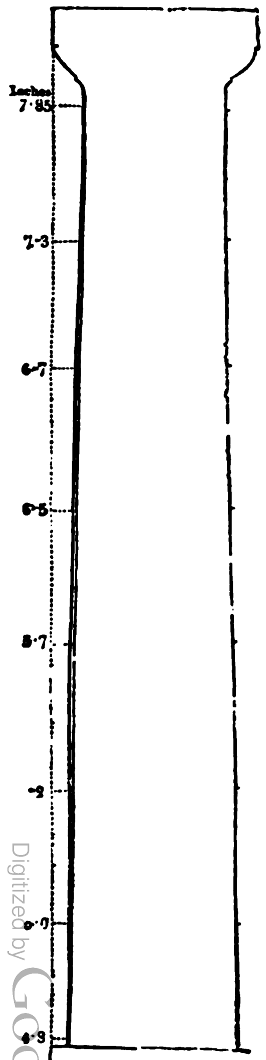
The Corinthian capital consists of the leaves of the acanthus [ACANTHUS] with two spiral horns at each of the four angles of the abacus. In the centre between these horns are two smaller spirals attached to the bell of the capital; under these are two rows of acanthus leaves regularly disposed, eight being placed in each row, and eight large double leaves supporting the angular horns, called also volutes. These are the leading features of the Corinthian capital, although some are more ornamental than others, and have enriched details about the abacus and the bell, which others have not. The most striking difference between the character of the Greek and Roman foliage of the Corinthian column is this: the leaves of the Greek have angular points, and are almost straight on the sides; the Roman are rounded on the sides; the section of the hollow of the Greek is angular, while the Roman is either a segment of a circle, or formed of two segments of a circle meeting in the centre of the hollow of the points of the acanthus leaf. The Greek leaves may be said to have more of the natural character of the acanthus, or the thistle, while the Roman is more artificial, and consequently less like the model from which the Greeks drew their capital. There are examples of the Greek Corinthian capitals, although much mutilated, in the Elgin collection in the British Museum; and casts of the Roman examples from the temple of Jupiter Stator, Mars Ultor, and the Pantheon, also in the British Museum. The bell of the Corinthian capital may be clearly understood from the annexed drawing of the mutilated single Corinthian capital found in the Temple of Apollo at Bassæ, near Phigaleia; and the accompanying drawings of Egyptian capitals, from the French work on Egypt, will show better than any elaborate description the strong resemblance of the Egyptian capital to the bell of the Corinthian capital, as we meet with the latter in the Temple of Jackly near Mylasa, and the Choragic monument of Lysicrates at Athens. The



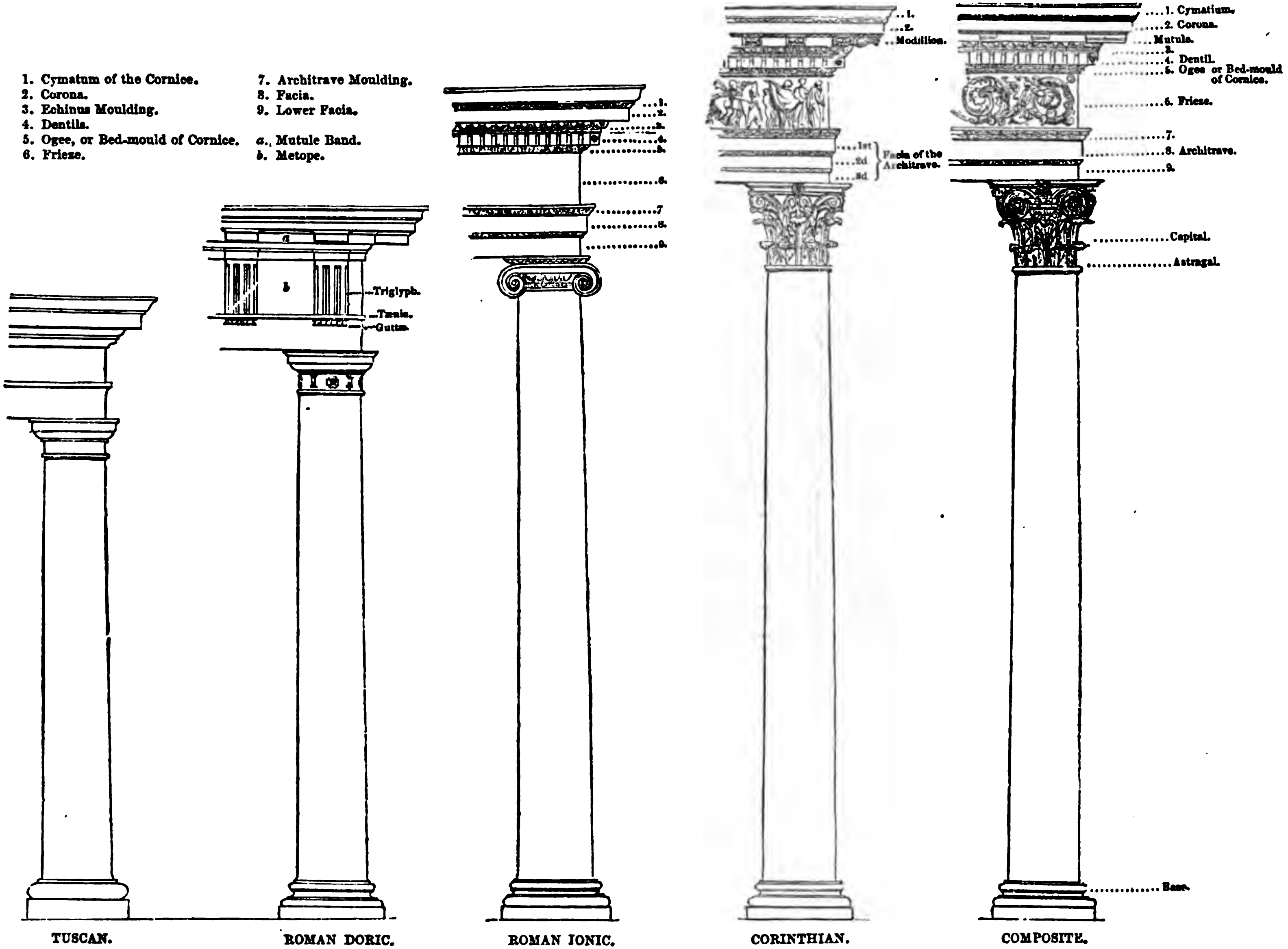
[Bell of a Corinthian Capital, a fragment from the Temple of Apollo, at Bassæ. From the 4th vol. of Stuart's 'Athens.']



[Egyptian Capitals.]



Entasis of a Greek Doric Column, from the 4th vol. of Stuart's 'Athens.'



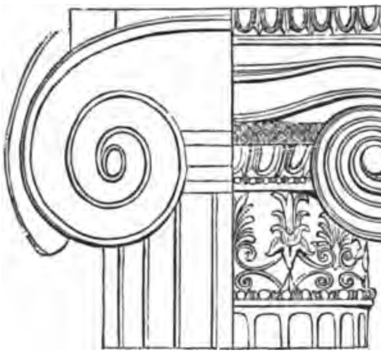
1. Cymatum of the Cornice.
2. Corona.
3. Echinus Moulding.
4. Dentils.
5. Ogee, or Bed-mould of Cornice.
6. Frieze.
7. Architrave Moulding.
8. Facia.
9. Lower Facia.
a., Mutule Band.
b. Metope.

TUSCAN. ROMAN DORIC. ROMAN IONIC. CORINTHIAN. COMPOSITE.

[Drawn to the same scale of two Modules, by dividing the diameter into two parts, and each part into thirty parts or minutes.]

order of the Temple of Vesta at Rome, which very much resembles the order of the Temple at Jackly, was most probably copied from it. Among other peculiarities, it has the same defect of the leaves projecting beyond the line of the shaft, and is the only building of the Corinthian order in Rome which has a Greek character. Some Greek Corinthian capitals have only one row of acanthus leaves, and are without the horns under the abacus, the bell being decorated with flat leaves called water-leaves, as in the Tower of the Winds at Athens.

The Ionic column is characterised by the two large spirals or volutes on two of its faces, connected under the abacus. The other sides connect these faces at right angles by a kind of baluster placed horizontally. Beneath this baluster and the astragal surmounting the top of the shaft of the column is the neck of the capital, which in some Greek examples is richly decorated; the baluster is also occasionally enriched. In some Ionic capitals all the faces of the volutes are conjoined at the extremities, the faces being curved inwards as in the Temple of Apollo at Bassæ. Ionic columns placed at the angles of porticos have sometimes the volute ingeniously formed at the angle, so as to present a voluted face either ranging with the volutes of the portico, or with the volutes of the column at the side of the portico. The angle column of St. Pancras Church, London, has the angular faces curved. The angular volutes in some Roman examples are formed of two half volutes placed at right angles to each other. The bases of the Ionic vary perhaps more than any other order. In Roman examples the Attic base is employed.



[Half the Ionic capital of the order employed in the cella of the Temple of Apollo at Bassæ.] [Half of the capital of the Erectheum.]

The Composite column, as its name implies, is a compound. It is formed of the Corinthian and Ionic, but partakes more of the Corinthian character and proportions.

The Roman Doric and Tuscan columns are shafts with moulded capitals and bases, the Doric only having a slight decoration of rosettes and buds in the neck of the capital, and some trifling additional mouldings. The Grecian Doric differs from the Roman both in proportion and in the mouldings of the capital, in the flutings being without fillets, and in its being almost always without a base.

An order includes the column with the whole of the entablature, or the superstructure raised on it, which is divided into architrave, frieze, and cornice.

All the great architects of the cinque cento, and after them those of the later Italian and French schools, have differed in the proportions and details of the orders, but for the most part in a trifling degree. The proportions of the five Roman orders which we have adopted here as our rule are those laid down in Sir William Chambers's 'Architecture,' and which are generally employed by the English architects of the present day. The proportions of the orders used by the Greeks are from the authority of Stuart. The measure by which the proportions of the orders are determined, is the diameter of the base of the shaft of the column, which is divided into two parts called modules, and each module is divided into 30 parts called minutes. This scale is in general use in all countries which derive their architecture from the Greeks and Romans.

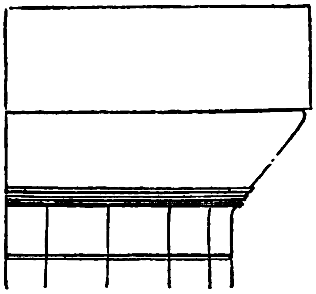
Thus the height of the shaft of the Tuscan order, from the upper line of the fillet of the base to the upper line of the astragal of the neck of the column, is 12 modules or semidiameters high; the base, including the plinth, is 30 minutes; the capital, 30 minutes; the architrave, 31½ minutes; the frieze, 31½ minutes; the cornice, including the bed-mould or ogee, 42 minutes; and the projection of the cornice, 42 minutes. The shaft of the Doric order is 13 modules 28 minutes; the base, 30 minutes; the capital, 32 minutes; the architrave, 30 minutes; the frieze, 45 minutes; and the cornice, 45 minutes. The projection of the cornice is 57 minutes. The shaft of the Ionic order contains 16 modules 9 minutes; the base, 30 minutes; the capital, from the upper line of the astragal, 21 minutes; the architrave, 40½ minutes; the frieze, 40½ minutes; and the cornice, 54 minutes. The projection of the cornice is 54 minutes. The Corinthian order has the shaft 16 modules 20 minutes; the base, 30 minutes; the capital, 70 minutes; the architrave, 45 minutes; the frieze, 45 minutes; the cornice, 60 minutes; and the projection, 58 minutes. The Composite order is similar in its general proportions to the Corinthian; and the columns of the Roman orders diminish in diameter about one-sixth; that is, are 50 minutes at the upper diameter of the shaft. But by a reference to the proportions of some of the columns of ancient edifices at the end of this article, some variations from this proportion will appear.

The Greek Doric varies very much in its proportions. The Doric of the Parthenon has the shaft and capital 10 modules 8 minutes high, and the entablature 3 modules 15 minutes. For a scale of the proportions of the leading features of some of the best known examples of antiquity, see the end of this article.

The Tuscan order, which is simple in its design, has a base formed of a plinth or squared piece of stone as a foundation, and a torus above it, surmounted with a fillet. The shaft is terminated with a fillet and an astragal, on which the capital is set, consisting of a necking (a prolongation of the shaft) and an ovolo moulding supporting the squared abacus, which is surmounted with a fillet. The architrave is a plain face with a broad fillet. The frieze also is a plain face. The cornice consists of an ogee, a fillet, an ovolo forming the bed-mould of the cornice, which consists also of the corona and fillet, surmounted with a cymatium.

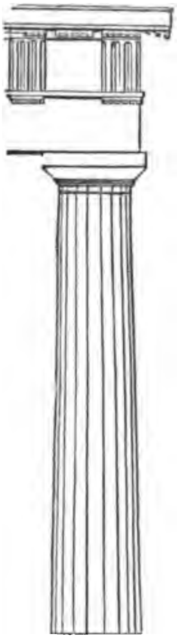
The Roman Doric, resembling in some particulars the Tuscan, is however very much richer. The Doric base consists of a plinth, a torus, a hollow moulding with a fillet above and below it; on the upper fillet is another torus and fillet, from which rises the shaft, curved where it springs from the fillet: the lower diameter of the shaft of a column is always measured from the point where this curve ends, and is joined to the straight line of the shaft. This is the Attic base, which is most commonly used in all the orders except the Tuscan. The shaft of the Doric is terminated like the Tuscan, and from the summit springs the capital with a neck enriched with rosettes and buds. Above the necking are three flat annular rings or fillets, then an ovolo moulding surmounted with the abacus, which is finished with a small ogee moulding and fillet. The architrave is a plain face, with a flat band (*tænia*) and a fillet under the triglyph, with six guttæ or drops under the fillet. The frieze is divided into compartments with a triglyph over each column and one or more between, according to the width of the intercolumniation. The triglyphs which project slightly from the face of the frieze are channelled with angular channels and two half channels at the sides of the triglyph. The metope, or space between two triglyphs, is square or nearly so; this, however, depends on the intercolumns. The triglyphs are bound together by a facia, surmounted by a small fillet under the bed-mould of the cornice, which is an ovolo moulding or an ogee. Over this is the mutule band with the mutules, square in form, projecting over the triglyphs; an ogee surmounts the mutules and the mutule band. The mutules support the cornice, consisting of the corona, an ogee and fillet, and a cavetto or hollow moulding. The soffit or under-side of the cornice is sometimes enriched with pannels, and guttæ are placed under the mutules. The Doric of the theatre of Marcellus at Rome has dentils with an ogee bed-mould in the cornice in lieu of the mutules; and the basilica by Palladio at Vicenza is without either mutules or dentils, having instead of them a bold ogee and ovolo moulding, and the architrave divided into two faciæ.

The Greek Doric differs considerably from the Roman, being almost always executed without a base. The flutings of the shaft are twenty in number without fillets; some examples are fluted only at the upper and lower extremities. The capital consists of a solid-looking abacus without any moulding above it, but supported by a very elegantly-curved echinus-moulding, which swells gradually out of the line of the shaft, being bound round by three annulets or rings near the top of the shaft, and on the under extremity of the echinus. A part of the shaft is also cut off by a sinking, or channel, cut into the shaft, forming the necking of the capital. The features of the entablature are very simple. [Greek Architecture.] The triglyphs are not very dissimilar in the Roman and Greek Doric, except in the setting them off on the frieze. In the Roman they are invariably set over the centre line of each column, the angle of a building being terminated by a portion of a metope. In the Greek the triglyph is invariably com-

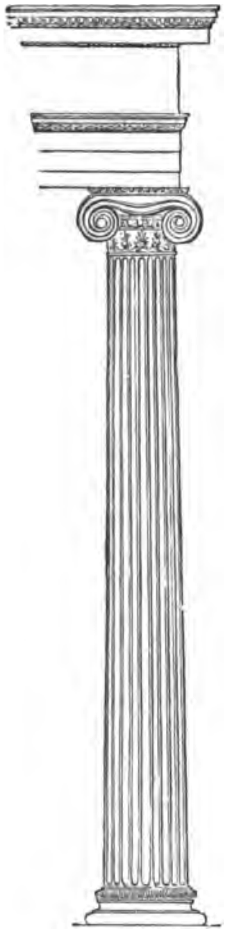


[Half the capital of the Parthenon at Athens.]

menced at the angle of the building, and not over the centre line of the column generally.



[Greek Doric order of the Parthenon.]

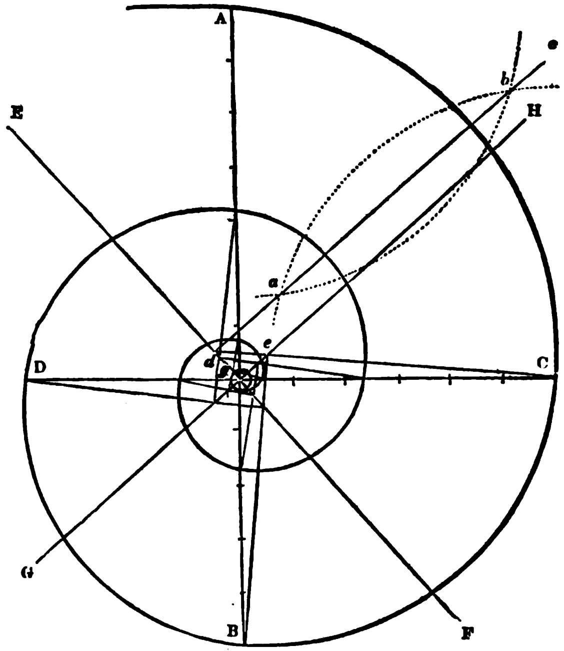


[Ionic order of the Erectheum at Athens.]

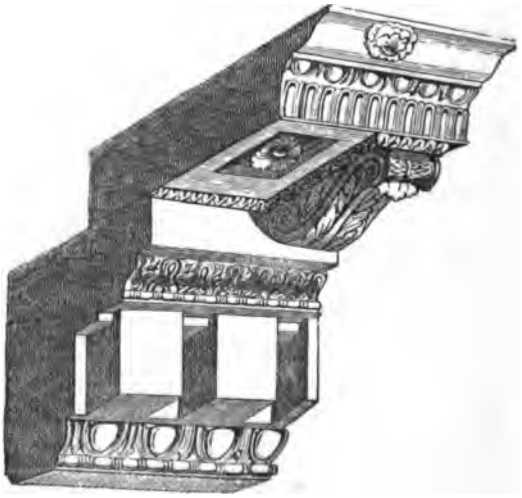
The Roman Ionic has an Attic base. The capital is formed with two volutes on two faces, and the volutes are connected by horizontal lines, though sometimes, like the Greek, the curved line is employed. The abacus is formed of a fillet and an ogee. Under the horizontal lines connecting the volutes is an echinus and astragal or bead-moulding enriched. The architrave is divided into two faciæ: the upper face is surmounted with a fillet and ogee enriched, and the lower with a small echinus, also enriched, having a narrow fillet underneath it. The frieze is usually plain, though the temple of Fortuna Virilis at Rome has a meagre decoration. The cornice is supported by an ogee moulding and dentils surmounted with a fillet, a bead moulding, and a large enriched echinus moulding. The cornice itself consists of a corona with a small ogee and fillet, on which is placed a cymatium. The volutes of the capital are connected at the sides by a pulvinus, or cushion, commonly called the baluster of the Ionic order. The Greek Ionic varies in proportion, and is superior in beauty to the Roman example. The method of drawing the Roman volute called Goldman's volute, is described in Sir William Chambers's Architecture.

The following is a very accurate method of drawing the Greek volute similar to the form of the volute of the Erectheum or Minerva Polias at Athens. Divide any perpendicular height, A B, into 12 equal parts. Through the 7th division *g* from the top, draw the line C D at right angles to A B. Then upon the line C D, from the centre *g*, set off towards C six of the seven divisions between A and *g*. Draw the lines G H and E F, at angles of 45 degrees to the lines A B and C D respectively. Bisect the line joining A and C by *b a*, and produce it till it cuts E F in *d*. Then from *d*, as a centre, with the radius *d* A or *d* C, describe the quadrant A C of the volute. Then join C *d*, cutting the line G H in *e*; from the point *e* describe with the radius *e* C or *e* B the quadrant C B, passing through B, the extremity of the line A B; and proceed in this manner with all the quadrants till you touch the centre. The centres of the segments A C, C B, B D, &c., are always found on the diagonal lines E F and G H.

The best examples of the Roman Ionic order are fluted, with twenty-four flutings, or semicircular channels, divided by a narrow fillet, which is part of the surface of the shaft of the column. Some Greek examples, as at Bassæ, have only 20 flutings, and are without fillets.

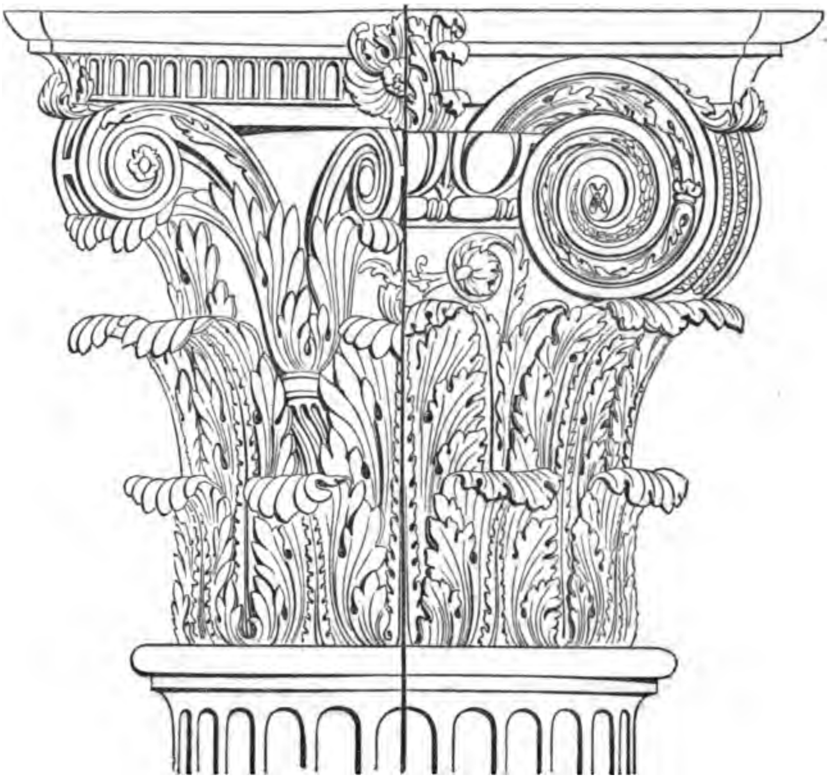


[Method of drawing the spiral forming the volute of the Greek Ionic of the Erectheum and Minerva Polias Temples, at Athens.]

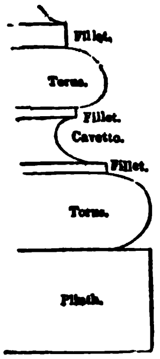


[A Modillion or Console of the cornice of the Temple of Jupiter Stator at Rome.]

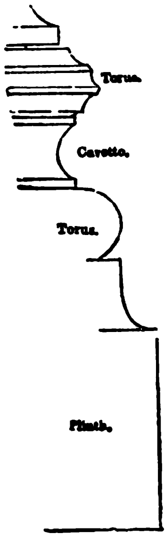
The general proportions of the Corinthian and Composite are the same, and they differ but slightly in their mouldings and enrichments. The base of both Corinthian and Composite is the Attic. The flutings of the shaft are, as in the Ionic, twenty-four, and divided by fillets. The capital is composed of two rows of acanthus leaves, eight in each row, and the upper row is placed between and over the divisions of the lower row. Four spiral volutes in each face rise out of two bunches of the acanthus leaf, and two of them are connected at the angles, and support the abacus formed of a cavetto and fillet, and an echinus, which are, except the fillet, sometimes enriched. The face of the abacus is formed of the segment of a circle, whose extremities are supported by the spiral horns or volutes. The connected ends of the abacus form a narrow face, round which the mouldings are continued, although in some rare instances these ends are pointed by the intersection of the two curved faces of the abacus. The leaves and volutes are carved round what is a continuation of the shaft, formed into the shape of a bell reversed. The lower row of leaves generally follows the line of the shaft, which is considered the best system of setting them off round the bell, although the Temple of Vesta at Rome has the leaves projecting beyond the shaft, and Inigo Jones has adopted this system in the Banqueting-house at Whitehall. The Corinthian architrave is divided into three faces, the Composite into two. The upper face is surmounted with an astragal and ogee enriched with a fillet; the middle face has above it a small enriched ogee, and the lower face an enriched bead. The frieze is enriched with figures or ornaments. The cornice is distinguished by its modillions and dentils, the latter are supported by an ogee and astragal enriched; the former by an enriched echinus and astragal. The modillion, which is set at intervals under the corona, will be better understood by the annexed view of a modillion of the Temple of Jupiter Stator, showing also the soffit, or under-side of the corona, with the enriched pannel between the modillions. The modillions support the corona, which is terminated with a cymatium, and this moulding, in the example before us, is decorated with lions' heads.


[Half the Corinthian capital, from Sir Wm. Chambers.] [Half the Composite capital, from Sir Wm. Chambers.]

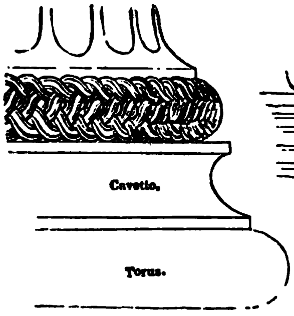
In the Composite order, mutules are sometimes employed instead of the Corinthian modillion. The orders are sometimes set on pedestals, consisting of a square shaft, called the die, with a moulded base set on a deep plinth. The die is surmounted with mouldings forming a capital, but in reality resembling more the cornice of an entablature.



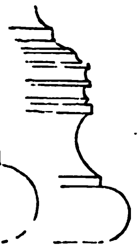
[Attic Base.]

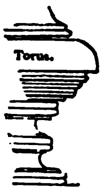


[Ionic Base at the Propylæa of Eleusis.]

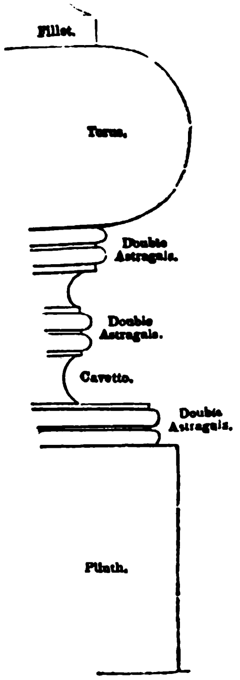


[Base of the Erectheum.]


[Base of the Minerva Polias.]



[Base of the order of the Temple of Apollo Didymæus.]



[Profile of the bases of the columns employed in the Temple of Minerva Polias, at Priene.]

Chambers allows, for the proportion of the die of the Tuscan pedestal, two modules, twenty-four minutes; for the Doric, three modules, six minutes; the Ionic, three modules, eighteen minutes; and the Corinthian and Composite, four modules. The bases and capitals are respectively—Tuscan, base twenty-eight minutes, capital fourteen minutes; Doric, base thirty-two, and capital sixteen minutes; Ionic base thirty-six, and capital eighteen minutes; and Corinthian, base forty, and capital twenty minutes.

Greek mouldings vary from the Roman, and are remarkable for being almost invariably drawn by the hand, and not formed, as in the Roman examples, of parts of circles struck with the compasses.

The flutings of columns vary in the depth and form of their curves; some, as in the Doric orders, are flat segments, without fillets between them, others are deep segments and semicircles, and others are semi-elliptical, and sometimes more than semi-elliptical, on the plan, as in the Jupiter Stator. Some columns of antiquity are decorated with spiral flutes, and some with leaves, as in the Temple of Clitumnus, and in a fragment in the British Museum.

The method of drawing the entasis of the columns employed in Roman architecture is described by Chambers, p. ii. of the Preface. It is done by means of a sliding rule, called the rule of Nicomedes.

Some account of the entasis of columns, by Mr. Jenkins, is given in the 4th vol. of Stuart's 'Athens,' with comparisons of the entasis of several columns, and more fully and elaborately in Mr. Penrose's treatise on the Parthenon, published by the Dilettanti Society. The Greek entasis is much more subtle than the Roman.

We may here observe, generally, that the principle of a base is support, which is admirably shown in the Attic base, where the two tori are proportioned and arranged, with the graceful sweep of the cavetto or hollow moulding between them, to sustain the shaft. The hollow-moulding gives additional height to the base, and the profile is in no part within the perpendicular line of the shaft, which would give it a weak appearance. The annexed variety of bases, from Greek examples (see preceding page), present some of the beauties and some of the defects even of Greek architecture. The base of the Apollo Didymæus shows weakness, and the torus of the Minerva Polias, at Prieue, appears too heavy for the delicate astragals and cavettos beneath.

Some columns, instead of being fluted the whole height of the shaft are, for about one-third from the base, made polygonal, each side being the width of the flute. This is particularly the case at Pompeii, where the Doric columns are often very slender. In the internal order of the Pantheon, the flutings are filled with cabling about one-third of their height. Cabling is a carved band projecting out of the fluting.

PROPORTIONS OF SOME OF THE COLUMNS EMPLOYED IN ANCIENT EDIFICES, WITH THE ENTABLATURE.

DORIC.

	Height of Column.	Diameter of Base.	Upper diameter of Shaft.	Height of Entablature.
	ft in.	ft. in.	ft. in.	ft. in.
Temple of Jupiter Olympius at Agrigentum	61 9	13 0	10 6	25 9·25
Ditto of Hercules at Agrigentum .	33 25	7 0·5	4 10	
Ditto of Apollo Epicurius at Bassæ, near Phigaleia	19 6·8	3 7·75	2 10·45	6 5·1
Ditto at Cadachio, in Corfu . .	11 3·25	2 0	1 6	3 10·75
Ditto of Minerva at Athens, called the Parthenon	31 4·9	6 1·8	4 9·75	10 10·56
Ditto of Theseus	18 7·18	3 3·4	2 6·63	6 5·9
Ditto at Corinth	23 8	5 5·10	4 4·10	
Doric Portico at Athens . . (Stuart's 'Athens.')	26 2·5	4 4·05	3 4·6	7 4·58
Trajan's Column, Roman Doric .	97 9·1	12 2·2	10 8·8	
Antonine Column, ditto . .	97 3·1	13 1·9	12 1·1	
Temple of Jupiter Hellenius, in Ægina	17 4·25	3 2·6	2 4·65	6 10·05
Ditto of Minerva at Sunium . .	19 9·15	3 4·3	2 6·65	6 6
Ditto of Jupiter Nemæus between Argos and Corinth	33 11·2	5 2·5	4 3	8 1·85
Propylæa at Eleusis		5 0·4	3 10·98	9 5·15
Temple of Ceres at Eleusis . .		6 6·27	5 4	12 8·96
Ditto of Diana Propylæa at Eleusis		2 7	2 0·75	5 0·74
Ditto of Nemesis at Rham..us .	13 5·45	2 4·8	1 10	including cymatium.

IONIC.

	Height of Column.	Base of Shaft.	Upper diameter of Shaft.	Height of Entablature.
	ft. in.	ft. in.	ft. in.	ft. in.
Temple of Apollo Epicurius at Bassæ		2 1·9	1 9·4	3 9·31
Ditto of Erectheus, Athens . .	21 7.50	2 3·3	1 11·2	4 11·25
Aqueduct of Hadrian . . .	19 1·95	2 2·35	1 11·1	4 2·90
Temple on the Ilissus . . .	14 8·300	1 9·4	1 6·2	3 7·282
Temple of Fortuna Virilis at Rome	27 0	3 2	2 8	6 8·6 architrave.
Temple of Bacchus at Teos . .	. .	3 3·6	3 1·8	2 5·4
Minerva Polias at Priene . .	. .	4 2·8	3 6·4	
Apollo Didymæus near Miletus .	. .	6 3·2	5 5·8	3 5·2
Propylæa at Eleusis . . .	. .	3 4·6	2 9·24	

CORINTHIAN.

	Height of Column.	Diameter of Base.	Upper diameter of Shaft.	Height of Entablatuie.
	ft. in.	ft. in.	ft. in.	ft. in.
Incantada at Salonica . . .	23 8·6	2 5·9		5 7·75
Temple of the Winds (without base)	13 6·85	1 7·4		
Monument of Lysicrates at Athens	11 7·65	1 2	0 11·65	2 8·218
Stoa, or Portico, at Athens . .	28 0·534	2 11·3	2 6·65	5 6·8
Arch of Trajan, Ancona . .	23 2·7	2 4·25	2 0·25	5 6·3
Ditto of Constantine . . .	27 4·1	2 11·2	2 9	7 1·2
Portico of Pantheon at Rome .	46 5·2	4 10·4	4 3·5	10 11·6
Interior of the Pantheon at Rome	34 10·4	3 8·2	3 2·3	8 2·9
Temple of Antoninus and Faustina	46 7·7	4 10·3	4 2·8	10 9·1
Ditto of Vesta at Tivoli . . .	23 6	2 5	2 1·8	4 3 architrave.
Ditto of Jupiter Tonans . .	46 6·2	4 8·3	3 11·4	10 0
Ditto of Jupiter Stator . . .	48 4·9	4 10·2	4 2·5	12 10·1
Ditto of Vesta at Rome . .	34 7·2	3 2·5	2 8·1	
Ditto at Jackly, near Mylasa, in Asia Minor, the supposed site of Labranda	27 2·8	2 10·35	2 3·6	5 6·6
Ditto of Mars Ultor at Rome .	57 11	nearly 6 ft.	5 1·6	3 10·5

COMPOSITE.

	Height of Column.	Diameter of Base.	Upper diameter of Shaft.	Height of Entablature.
	ft. in.	ft. in.	ft. in.	ft. in.
Arch of Titus	20 8·5	2 0·2	1 9·4	5 4·4
Septimius Severus	27 10·5	2 10·6	2 6·5	6 7

Vitruvius makes the height of the Doric (Roman) seven times the diameter; the Ionic, 8½; and the Corinthian, two-thirds higher than the Ionic, or nine diameters and one-sixth. The proportions of Palladio and Vignola differ; the latter are, we believe, preferred by the French school. See the Architecture of Palladio and Vignola. The proportions of the columns given above are from Stuart's 'Athens;' Taylor and Cressy's 'Rome;' 'Ionian Antiquities;' 'Unedited Antiquities of Attica,' &c.

In studying these works the student should be guided by the figures denoting the dimensions rather than by the outlines.

COLUMN. This term is applied to any formation of troops in which the divisions are placed behind one another exposing a narrow front to the enemy. Thus a column of battalions is formed by a number of successive battalions being deployed close behind one another; while a battalion is said to be in column when the companies of which it is composed are deployed in rear either of one of the flank companies, or in rear of the two centre companies or two centre subdivisions. A battalion is said to be in open column when the distance between the companies is such as to admit of their wheeling into line; and to be in close column when the front rank of one company is within a few paces of the rear rank of the one before it, while the half distance column is intermediate between the two.

The formation of the Greek and Roman armies was almost wholly in column, both for attack and defence. And it was only on the introduction of fire-arms and field artillery that, from the ravages committed in dense masses, a more extended formation was adopted. Gustavus Adolphus was one of the first to employ a more open formation.

In the wars of the French Revolution, at the close of the 18th century, the dense column was universally employed, almost of necessity, as the raw levies were not sufficiently trained to be easily handled in any other formation, and the loss of life entailed was not considered by their generals, to whom success, however dearly purchased, was the only obligation. From these victories and those of the first Napoleon, who also employed very dense columns in attack, it resulted that close columns came much into repute, and their advantages as compared with other formations are much contested points among military writers, especially between English and foreign authors; the former principally upholding the formation in line, which had been so successfully applied by the Duke of Wellington in the Peninsula and at Waterloo against the columns of the French. Still we must not blind ourselves to the fact, that a formation which can be applied with troops of such *morale* as the English may not be the best with others. Jomini, when discussing this question in his 'Précis de l'art de la Guerre' remarks, "Dès lors quelle serait l'armée Européene (si l'on excepte les Anglais), que l'on pût se hasarder à deployer en lignes sur deux rangs." And as a three rank formation makes a column too dense, and it would be next to impossible to change from a three to a two rank formation, according as a deployment or column was required, he recommends the constant employment of small columns of attack on a two rank formation.

From the great advantage that the formation in column gives in the movement and handling of troops, and the impossibility of conducting extended movements in line, even if there were any object in attempting it, the column will always in some shape or other be employed in all the preliminary dispositions of a battle, and it is only when within range that the question arises as to formation. For the offensive, the objects to be kept in view in the formation of troops, are mobility combined with solidity and impulse; while for the defensive, solidity should be united with the greatest possible amount of fire. Now the column, if not too deep, combines the former qualities in the highest possible degree, and in an attack firing is not required; indeed, if the men once commence to fire, the attack will in all probability fail, for the impulse and impetuosity of the charge being lost, if received by a steady fire from the enemy, they soon get into confusion and retire. At the same time it must be remembered, that the deeper the formation the greater will be the carnage, especially if artillery be employed in the defence of the position attacked; and therefore, if the troops are sufficiently steady and well disciplined to be managed under fire in line they will have a great advantage. The deployment from the column into line for attack, should not however take place at too great a distance from the point attacked, as, especially in moving over rough ground, troops in line soon lose their formation; whilst on the other hand, if the deployment is too long deferred, and the column while deploying is received with a heavy fire, it is likely to be thrown into disorder, and if then promptly charged, (as at Waterloo), will probably be routed.

Jomini, while condemning the formation of troops in large masses, as at Waterloo, argues in favour of battalion columns, formed on the two centre companies, with two companies as skirmishers, thus making the depth only six ranks, as a good general formation for attack. For he says, that although at Talavera, Busaco, Fuente d'Onor, Albuera, and Waterloo, heavy columns, (in one case twelve battalions deployed behind one another, or a depth of thirty-six ranks,) had been annihilated by the fire and attack of the English infantry in line, on front and flank, yet that this is no proof against small battalion columns, which have not been sufficiently tested. And for defence, he considers the first line should be deployed, and the second in battalion columns. The success of the line or column will, however, depend upon its proper application by the general, according to the modifying circumstances of ground, whether broken or even, of discipline and of *morale*. And no general rule can be laid down, though the Duke of Wellington appears to have almost always deployed his columns before attacking.

COLURES (*αἱ κόλουροι, colūri*). The term originally applied to any great circles of the sphere passing through the poles, but came at last to mean only the circles which also pass through the equinoxes and the solstices, which are distinguished as the equinoctial and solstitial colures. These terms are now of very little use, as the fact of a star being upon either circle is attended with no remarkable phenomenon. Astronomers would describe a star on the equinoctial colure as having either no right ascension, or twelve hours of right ascension, according as it is on the vernal or autumnal half of the circle; and a star on the solstitial colure as having either six hours or eighteen hours of right ascension, according as it is on the summer or winter side of the heavens. If we say that the sun is on the equinoctial colure at the quarter-days of March and September, and on the solstitial colure at those of June and December, we rather elucidate the term colure than derive information from it.

The solstitial colure passes through the poles of the ecliptic also, and might be called an ecliptic colure; but the other circle, which passes through the equinoxes and the poles of the ecliptic, has no distinct name, and would be best described as the circle from which celestial longitude is reckoned.

COLZA, OIL OF. The seeds of the *Brassica campestris oleifera* yield by expression about 39 per cent. of a yellow oil, which possesses a specific gravity of ·9136, and solidifies at 21° Fahr. It is a mixture of the glycerine compounds of two acids, namely *Brassic acid* ($C_{44}H_{42}O_4$). The other acid resembles *oleic acid*, but does not seem to be identical with it. Colza oil is used both for lamps and in cookery.

COMA, a Greek word (*κῶμα*), signifying profound sleep; a morbid condition of the brain, attended with loss of sensation and voluntary motion, the patient lying as if in deep sleep.

It can scarcely be considered a primary or idiopathic disease; it is rather symptomatic of that condition of the brain which, when in sufficient intensity, produces apoplexy. If it be regarded as a positive disease, it must be considered as a milder form of apoplexy. It exists in different degrees of intensity; several of which degrees, as they are attended with some variety in the symptoms, and are dependent on some modification of the pathological condition of the brain, so they have acquired distinct names. When there is a state of mental and physical torpor, indicated by an almost constant tendency to sleep, and great inaptitude for muscular exertion; when the patient is sensible only as long as he is strongly excited, and as soon as the external stimulus is withdrawn, lapses into a state of forgetfulness, the affection is called Lethargy. When no distinct consciousness returns, however the patient may be roused or stimulated, though there still remain some indication of feeling on the application of mechanical irritation, as on being pricked or pinched, the affection is called Carus. But when the insensibility is so great that the patient indicates neither sensation nor feeling, whatever mechanical stimulus be applied, this state is often called, by way of eminence, Coma. This comatose state invariably accompanies apoplexy; and, as has been stated, coma, when intense, passes into apoplexy.

The abolition of sensation and voluntary motion (animal functions), which constitutes coma, is always attended with a greater or less disturbance of the organic functions. The circulating system is disordered; the pulse at one time is slow and full, and at another quick and small. The respiration is laborious, and is commonly preternaturally slow. The power of generating animal heat is almost always diminished, the skin being cold and clammy; though there are cases in which the temperature is elevated somewhat above the natural standard. The countenance is usually pale and sunk; the pupils dilated, but in the worst cases contracted; the position of the body is supine; in the worst cases there is a constant tendency to sink down in the bed; the limbs are motionless; and the evacuations, if not wholly retained, which is usually the case, are passed without consciousness.

In coma there is an exhaustion or suppression of the sensorial powers, in other words, an abolition of the cerebral functions. This state of the nervous is always attended with a morbid condition of the vascular system. There is either a congestion of the capillary blood-vessels, occasioning obstructed circulation of the blood through the brain, or there is too rapid and violent a flow of blood through the cerebral vessels; or an inflammatory condition of the blood-vessels; or an extravasation of blood, or an effusion of serum into the cerebral substance. In addition to its disordered motion, there is also sometimes a depraved quality of the blood. There is reason to believe that to some morbid change in the constitution of the blood, the coma incident to bad types and advanced states of fever is mainly owing.

The morbid condition of the brain, on which coma depends, may be induced by any of the causes which have been enumerated as constituting the predisposing and exciting causes of apoplexy. [APOPLEXY.]

COMA BERENI'CES (Constellation), the hair of Berenice, placed among the stars by the astronomer, Conon, in memory of Berenice, the wife of Ptolemy Euergetes. (B.C. 246.) The legend is, that she had dedicated this hair to Venus, in case of her husband's safe return from Asia, and that it disappeared from the temple in which it was placed, and was never seen again till found in the starry heavens, where it now is, close to the tail of the Lion, and passing the meridian about an hour before Arcturus. [BERENICE.] Geminus attributes the constellation to Callimachus, who mentions it, as do Catullus and Pliny. Ptolemy does not place the stars now belonging to this constellation by themselves, but in the tail of the Lion; and Hyginus makes no separate mention of it. It was constantly mentioned by writers on the sphere, but not figured or catalogued separately, as far as we can find, till the time of Tycho Brahé.

The constellation Coma Berenices will be found shut up in the triangle formed by the three bright stars, Arcturus, β Leonis, and α Canum Venaticorum. It contains no stars of conspicuous magnitude.

COMB MANUFACTURE. Combs are generally made of a thin plate of wood, horn, tortoise-shell, ivory, bone, or metal, which may be either flat or curved, having one or two of its edges indented with narrow slits, which divide the substance of the comb into long, fine pointed teeth. Combs employed in the woollen manufacture are described in the article relating to that subject. Curry-combs, used in dressing horses, consist of a number of iron plates notched on one edge to form saw-like teeth, and attached by the other edge to an iron back, in parallel lines, so as to form an instrument the action of which is between that of a scraper, a comb, and a brush.

In the mode of cutting and shaping the plates of which combs are formed there is little call for remark; but in the act of comb-cutting much ingenuity has been called into exercise. The hand-method is by means of a double saw, consisting of two separate fine saws, placed parallel with each other, and adjusted to such a distance as to embrace a tooth of the required fineness between them. These two saws are so arranged that while one cuts into the comb to the full depth required, the other cuts only about half that depth; by this contrivance the uniformity of the comb is secured; because, while the deeper saw is completing the first cut, the shallower one is forming the commencement of the second; and when, on the completion of the first cut, the deep saw is put into the second cut to complete it, the shallower one immediately commences a third. The cuts thus formed are subsequently enlarged and rendered smoother by means of a very thin wedge-shaped file, which also points the teeth. With such accuracy may these operations be performed, that delicate ivory combs, with from fifty to sixty teeth in an inch, are produced in this way. Though this method of comb-cutting is still practised, a superior and much quicker mode by means of circular saws and revolving cutters for pointing the teeth has been long in use.

By the above-described modes of comb-cutting all the material of the interstices between the teeth, is lost or destroyed; but by the operation known as the *parting* of combs such loss or waste of material may be avoided in the manufacture of combs of tortoiseshell, horn, or any other tough material; two combs being, by this process, made out of one piece, the teeth of one being cut, by the pressure of chisel-like instruments, out of the interstices of the other. Mr. Lyne's machine, for this purpose, is worked by the alternating action of a lever handle. The piece of tortoiseshell or horn is secured upon a traversing carriage, which is capable of motion in a direction perpendicular to that of the teeth of the comb. This carriage is made hollow, to receive an iron heater, the heat of which softens the horn, and thereby renders it more easy to cut. Between each movement of the carriage the cutter, which is a chisel equal in breadth to the length of the intended teeth of the comb, is brought down with sufficient force to cut completely through the horn or tortoiseshell. As the teeth are not required to be perfectly parallel, but in a slight degree wedge-shaped, the successive cuts of the chisel must incline a little obliquely, first in one direction, and then in the other, for which provision is made by an arrangement for alternately changing the position of the cutter during its descent. A pair of very narrow chisels mounted at right angles with, and at the ends of, the long cutter, serve, by their alternate descent, to connect each pair of cuts at their converging extremities, so as to detach the ends of the teeth. In Mr. Rogers's machine for the same purpose, everything is effected by the continuous turning of a winch, which, by means of a crank, works a double cutter, the two chisels of which are capable of adjustment according to the size of the teeth, while the screw for moving the bed or carriage is turned by means of a cog-wheel upon its axis, working into another on the axis of the winch. The extent of motion between each operation of the cutter is regulated by varying the relative sizes of these cog-wheels.

Among recent novelties in comb-making is Mr. Griffith's curious patent, in 1852, for "galvanic combs," of which the teeth are alternately of copper and zinc, while the handle is hollowed into a chamber for containing a roll of flannel moistened in acid solution. The inventor seems to expect a beneficial galvanic action by combing the hair with this apparatus. A more promising novelty is the application of the very tough substance called vulcanised india-rubber [CAOUTCHOUC MANUFACTURES] as a material for combs.

COMBAT, SINGLE. [DUEL.]

COMBINATION LAWS. The laws known by this name were repealed in 1824. Till then any combination of any two or more masters, or of any two or more workmen, to lower or raise wages, or to increase or diminish the number of hours of work, or quantity of work to be done, was punishable at common law as a misdemeanour: and there were also thirty-five statutes in existence, most of them applying to particular trades, prohibiting combinations of workmen against masters. The Act passed in 1824 (5 Geo. IV. c. 95) repealed all the statute and common law against combinations of masters and of workmen; provided a summary mode of conviction, and a punishment not exceeding two months' imprisonment for violent interference with workmen or masters, and for combinations for violent interference; and contained a proviso with regard to combinations for violent interference, that no law in force with regard to them should be altered or affected by the Act. But all the common law against combinations being repealed by the Act, this proviso was considered as of no force; and the Act also went beyond the intentions of the framers in legalising combinations unattended with violence for the purpose of controlling masters in the mode of carrying on their trades and manufactures, as well as peaceable combinations to procure advance of wages or reduction of hours of work. The Act was passed after an inquiry into the subject by a committee presided over by Mr. Hume, which reported to the House the following among other resolutions:—

"That the masters have often united and combined to lower the rates of their workmen's wages, as well as to resist a demand for an increase, and to regulate their hours of working, and sometimes to discharge their workmen who would not consent to the conditions offered to them; which have been followed by suspension of work, riotous proceedings, and acts of violence.

"That prosecutions have frequently been carried on under the statute and the common law against the workmen, and many of them have suffered different periods of imprisonment for combining and conspiring to raise their wages, or to resist their reduction, and to regulate their hours of working.

"That several instances have been stated to the committee of prosecutions against masters for combining to lower wages, and to regulate the hours of working; but no instance has been adduced of any master having been punished for that offence.

"That it is the opinion of this committee that masters and workmen should be free from such restrictions as regard the rate of wages and the hours of working, and be left at perfect liberty to make such agreements as they may mutually think proper.

"That therefore the statute laws which interfere in these particulars between masters and workmen should be repealed; and also that the common law, under which a peaceable meeting of masters or workmen may be prosecuted as a conspiracy, should be altered."

Immediately after the passing of this Act a number of widely organised and formidable combinations arose in various trades and manufactures for the purpose of controlling the masters as to the way in which they should conduct their business; and the extent to which the Act had repealed the common law being doubtful, and the Act having clearly gone beyond the resolutions on which it was grounded in legalising combinations, Mr. Huskisson, then President of the Board of Trade, moved early in the session of 1825 for a committee to consider the effects of the Act 5 Geo. IV. c. 95; and a committee was appointed with Mr. (afterwards Lord) Wallace, then Vice-President of the Board of Trade, for its chairman. This committee recommended the repeal of the Act of the previous session, and the enactment of another; and in consequence of their recommendation the 6 Geo. IV. c. 129, was passed, which is the Act now in force relative to combinations.

This Act repealed the 5 Geo. IV. c. 95, and all the statutes which that Act had repealed. It relieved from all prosecution and punishment persons meeting solely to consult upon rate of wages or hours of work, or entering into any agreement, verbal or written, on these points. And it provided a punishment of not more than three months imprisonment, with or without hard labour, for any one using violence, or threats to make a workman leave his hiring, or return work unfinished, or refuse to accept work, or belong to any club, or contribute to a common fund, or pay any fine for not belonging to a club, or contributing to a common fund, or refusing to conform to any rules made for advance of wages or lessening of the hours of work, or regulations of the mode of carrying on any business, and for any one using violence to make any master alter his mode of carrying on his business.

By the Act 6 Geo. IV. c. 129, therefore combinations of masters and workmen to settle as to rate of wages and hours of labour are made legal and freed from all punishment; but the common law remains as it was as to combinations for otherwise controlling masters. Although, therefore, workmen may conspire together not themselves to work under certain wages, they must carry out their object by lawful means, and cannot intimidate or prevent masters from employing, or workmen from taking employment, at any wages those other workmen may agree for. (Reg. *v.* Rowlands, 2 Den. C. C. 364.)

By 9 Geo. IV. c. 31, assaults in pursuance of a combination to raise the rate of wages are made punishable by imprisonment and hard labour.

COMBINATIONS AND PERMUTATIONS. By the word combination is usually meant any selection which can be made out of a number of different objects without reference to the order in which they are placed; while by a permutation is meant a combination in which different orders of position are to be considered as constituting a specific difference. Thus *a b c d*, *a c b d*, *d a c b*, are all the same combination of four out of the alphabet, but different permutations of four. The investigation of questions relating to combinations, &c., is the principal mathematical part of the theory of probabilities, and was first considered in detail, with reference to that science, by James Bernouilli and Montmort (see Library of Useful Knowledge: 'Probability'); but the common rules had previously found their way into arithmetical treatises. The enormous number of different arrangements of which objects are susceptible, even when their number is not large, drew early attention to the subject. We shall give some of the most simple rules, and a help to calculation for high numbers.

I. The number of permutations having x in each, which can be made out of X things, is the product of x terms of the series,

$$X, X - 1, \quad X - 2, \quad X - 3, \&c.$$

Thus, out of 10 things, there are 10 × 9, or 90 permutations of two; 10 × 9 × 8, or 720 permutations of three; 10 × 9 × 8 × 7, or 5040 permutations of four; and so on. Finally, the number of different arrangements which the whole ten will admit of, say the number of changes which can be rung on ten bells, is

$$10.\ 9.\ 8.\ 7.\ 6.\ 5.\ 4.\ 3.\ 2.\ 1. \text{ or } 3{,}628{,}800.$$

II. When the whole number of things, X, contains a which are alike of one sort, b which are alike of another sort, &c., the total number of arrangements of the whole is not the product of X, X — 1, &c., down to 1, but that product divided by the product of 1, 2, 3 . . . . up to a, then by that of 1, 2, 3 . . . . up to b, &c. This result can be most easily formed by striking out common factors from the numerators and denominators.

III. In the last case, the number of permutations of x out of X being required, no simple rule can be given, but each case must be solved by itself. For instance, how many permutations of three can be formed out of

$$a \quad a \quad a \quad b \quad b \quad c.$$

(1.) All being different, 3. 2. 1. or 6. (2.) Where a is repeated twice, we have 6. (3.) Where a is repeated three times, one only. (4.) Where b is repeated twice, we have 6. In all, 19.

IV. The number of combinations of x things out of X, *all different*, is

prod. of x terms of X, X — 1, X — 2, &c.
divided by
prod. of x terms of 1, 2, 3, &c.

Thus out of 10 things, the number of combinations of four is 10. 9. 8. 7. divided by 1. 2. 3. 4, or 210. The best way of arriving at this result is by destroying common factors, which shows it to be 5. 3. 2. 7. Observe also that we may shorten this process, when x is greater than the half of X, by finding out, not how many selections can be taken, but how many remainders can be left. Thus the number of combinations of 25 out of 30, is the same as the number of combinations of 5, for 25 can only be taken in as many ways as 5 can be left.

V. The number of combinations of x things out of X, any repetition being allowed, is

prod. of x terms of X, X + 1, X + 2, &c.
divided by
prod. of X terms of 1, 2, 3, &c.

VI. The number of ways in which n places may be filled up from x

letters, allowing any letter to be repeated in all or or any of the places, is x^n, or the product of $x, x, x, \ldots.$ (n factors in all). This is the number of permutations of n out of x, allowing repetition.

VII. The number of ways in which n different letters can be distributed into x boxes, all possible modes of distribution being equally allowable, is x^n.

VIII. The total number of combinations of all sorts out of x things, from one at a time up to all together, both inclusive, is 2^x, or 2. 2. 2. . . . (x factors in all) diminished by 1. Thus out of 4 things, there are $2^4 - 1$, or 15 different sections: they are

abcd, bcd, acd, abd, abc, ab, ac, ad, bc, bd, cd,
a, b, c, d.

Among the curiosities of this subject, it will suffice to mention the following: The number of all possible arrangements of letters, repeated or not, and capable of being pronounced or not, up to words of 24 letters, is of the following order of magnitude: Take a million of millions; repeat it a million of million times: the result is between 1391 and 1392 millions of such numbers. As an instance of the manner in which the dropping of consonants and confusion of vowels may permit possible alterations of spelling, M. de Mairan computed that the word *Hainaut* might be spelt in 2304 different ways, so as to be pronounced in the same way by as many different Frenchmen, or very nearly so.

The most useful proposition in the higher part of the theory of combinations is the reduction of the formula $1.\,2.\,3.\ldots.\,(x-1)\,x$ to a very close approximation, which can be easily calculated by logarithms. It affords at the same time a useful lesson to those who have not studied mathematics at all, or very little; we have seen ignorance comport itself with laughter more than once at the idea of the preceding product being found by employing the proportion which the circumference of a circle bears to its diameter. But let $\pi = 3{\cdot}141593$ be this proportion; $\epsilon = 2{\cdot}718282$, the base of Napier's logarithms: then we have

$$1.2.3.\ldots\ldots(x-1)\,x = \sqrt{2\,\pi\,x}\left(\frac{x}{\epsilon}\right)^{x} \text{ very nearly.}$$

which is a little too small, but the error is only about the $12x$-th part of the whole: less than 1 per cent. even when x is so low as 10. The expression can easily be calculated by logarithms. Tables of the logarithms of this product will be found at the end of the article 'Theory of Probabilities,' in the 'Encyclopædia Metropolitana.' For an instance of the computation, see the Library of Useful Knowledge: 'Examples of Arithmetic,' &c., p 45.

COMBINING PROPORTION. [ATOMIC THEORY.]

COMBINING VOLUME. [ATOMIC VOLUME.]

COMBUSTIBLE. In its more restricted and usual sense, this term signifies a body which is capable of combining with oxygen, with the evolution of so much heat as to become luminous or incandescent. [COMBUSTION.]

COMBUSTION is a term usually restricted to describe the phenomenon that ensues when chemical action is sufficiently intense to produce light and heat. The burning of coal, wood, paper, candles, oil, or coal-gas are familiar illustrations of combustion. Less common, but more brilliant, instances of combustion are seen in the explosion of gunpowder, or fireworks, or in the burning of steel-wire, charcoal, or phosphorus in oxygen gas.

In the examples of combustion above alluded to, the action lies between the burning body on the one hand, and pure or diluted oxygen on the other; and inasmuch as our world is enveloped in an atmosphere of which the most important constituent is oxygen, it follows that all ordinary instances of combustion are owing to the rapid oxidisation of bodies at a high temperature. It would be wrong, however, to suppose that the word combustion expresses no other actions than those indicated. Many substances burn equally well in atmospheres from which oxygen is excluded altogether, and in some cases even burn more readily than they would under similar circumstances in pure oxygen. For instance, when the metals arsenic or antimony are finely powdered and thrown into an atmosphere of chlorine, they instantly ignite, and burn with evolution of light and heat; in fact, literally undergo combustion.

Combustibles, and *supporters of combustion* or *non-combustibles*, are terms used to designate two distinct classes of substances. Air, oxygen, chlorine, &c., are non-combustible, that is, in the common acceptation of the word; they do not burn, but they support the combustion of other substances, such as wood, coal, &c., which latter are called combustibles. The phraseology is, however, purely conventional, and only applicable so long as the circumstances under which it is applied remain the same. For instance, common coal-gas burns in atmospheric air, and under these circumstances the gas is called the combustible and the air the non-combustible or supporter of combustion. But change the conditions, fill a jar with coal-gas, introduce a jet of common air and ignite the latter, perfect combustion will then go on at the jet: the air may now with equal propriety be said to be the combustible and the gas the non-combustible, for the gas just as much supports the combustion of the jet of air as in the former case the air supported the combustion of the jet of gas; in fact, both are equally combustible, and both equally support the combustion of each other. In like manner a jet of mercury vapour is combustible in an atmosphere of chlorine, and a jet of chlorine is combustible in an atmosphere of mercury. In these and other similar instances the chemical action between the two bodies at their line of contact with each other, is sufficiently intense to produce light and heat, and consequently it is at that line that the phenomenon of combustion ensues.

Spontaneous combustion is combustion that is set up between two bodies at common temperatures, without any application of artificial heat. Thus, the burning of arsenic and of antimony in chlorine, previously referred to, are examples of spontaneous combustion. In kindling a lucifer-match friction is necessary to produce a temperature at which the exposed phosphorus will ignite; but a piece of phosphorus, exposed to the direct rays of the sun on a warm day, will inflame spontaneously. Tow or cotton waste, moistened with oil and exposed to the air, frequently undergoes spontaneous combustion, on account of the attenuated state of the oil produced by the fibre being a condition favourable to the chemical action of the oxygen of the air upon it; on this account great care should be taken in factories where oily machinery is cleaned with cotton waste, to prevent the accumulation of materials of that description.

The spontaneous combustion of the human body is a subject that properly belongs to the past century; nevertheless, as some ignorant people at the present day believe that excessive and long-continued drinking of ardent spirits sets up a condition of system under which spontaneous burning of the body may ensue, it may be as well to notice here that, before the causes of combustion were investigated, it was customary when any person was found burnt to death and the origin of the fire could not be discovered, to assume that combustion had occurred spontaneously. The hypothesis has, however, long since been found to be untenable, and, amongst intelligent persons, is now only held by a few who have not taken the trouble to acquaint themselves either with the laws of heat or the causes of the phenomenon of burning.

The term combustion is sometimes used to describe certain chemical actions in which heat is evolved but no light. Thus the heat of the body is sometimes spoken of as being caused by the combustion of the carbon of the blood with the oxygen of the air. Occasionally, the word is used to denote particular chemical actions where not only no light but even no sensible heat is evolved; thus, the decay of animal and vegetable matter is said to be due to slow combustion. It is, however, far more convenient to speak of such as phenomena of oxidation, and restrict the term combustion to the meaning given to it at the commencement of this article.

COMEDY. [DRAMA.]

COMENAMIC ACID. [MECONIC ACID.]

COMENIC ACID. [MECONIC ACID.]

COMETARY BODIES. [COMETS.]

COMETS. This term has been applied to bodies of a nebulous aspect which occasionally appear in the heavens, accompanied in the more conspicuous cases by a long train of light called the *tail*. The principal part of a comet's structure, in contradistinction to the last-mentioned appendage, is denominated the *head*. The outline of the head is hazy and ill defined; hence the origin of the term *comet* (*κομήτης*, from *κόμη*, hair). The head gradually increases in brightness towards the centre, where it assumes a planetary aspect. In some instances it exhibits a small bright central point, bearing a resemblance to a star. This point is called the *nucleus*. The head of a bright comet is usually shrouded in a paraboloidal envelope of light, the prolongation of which forms the tail. The tail is turned in the direction opposite to the region in which the sun is situate. Its outline is gently curved, being convex on the side towards which the comet is travelling. This remarkable appendage frequently extends over a considerable arc of the heavens, imparting a grand and mysterious aspect to the object with which it is connected. Nor is the length of the tail merely apparent; on the contrary, it not unfrequently extends to an enormous distance in space. Thus, for example, the tail of the great comet of 1843 attained a maximum length of 150 millions of miles; while the tail of the great comet of 1858, at the time of its greatest development, did not certainly fall short of 50 millions of miles in length.

The tail, however, must not be considered as forming an essential part of the structure of a comet. Multitudes of bodies of this class have been observed in modern times, which exhibited merely a round nebulous mass of light without the slightest vestige of a tail. Such bodies are generally visible only by the aid of the telescope; but even in some instances of comets of conspicuous magnitude, no trace of a tail has been discovered. For example, the comet of 1585, observed by Tycho Brahé, is said to have exhibited neither tail nor coma, but appeared perfectly round like a planet. ("Planè rotunda extitit; nec ullam caudam aut barbam in unam magis quam in aliam partem portendebat."*) Cassini relates a similar fact with respect to the comets of 1665 and 1682.

The appearance of a great comet in the heavens has in all ages strongly attracted the attention of mankind. During the earlier periods of history, bodies of this class were generally contemplated with superstitious dread as omens of divine displeasure, and were regarded as the precursors of some calamity to the human race. Even in the present day this opinion is prevalent among the ruder nations of the earth. The intelligence brought by the Overland mail respecting the terror caused throughout Egypt and India by the great comet of 1858, must be fresh in the recollection of every reader; and we may easily infer from this circumstance what must have been the impression produced on the still ruder tribes of Central Africa by the same mysterious object during the course of its rapid passage towards the southern hemisphere. The ancient philosophers failed to arrive at any just conclusions respecting the nature or movements of comets. According to Aristotle, comets are merely bodies of terrestrial origin, which are generated in the upper regions of the atmosphere. This opinion seems to have been generally entertained by astronomers down to the time of Tycho Brahé, who, by a discussion of the observations of the comet of 1577, finally succeeded in demonstrating that it must have been situate beyond the moon's orbit. Henceforward comets assumed their true place as bodies of celestial origin. It still remained to discover the nature of the paths which they described in the heavens, and to unfold the laws of their movements. Tycho Brahé imagined that comets move in straight lines; and Kepler seems to have entertained the same opinion. Hevelius was the first who conjectured that the path of a comet might be curvilinear; and Doerfel (1681) showed that the comet of 1680 actually described a parabola having the sun in the focus.

---

* Epist. ad Landgrav. p. 13.

It was reserved for the immortal Newton to discover the real nature of the movements of comets, and to demonstrate that, like the planets, they are mainly regulated by the attractive force of the sun. In the course of his researches on the principle of gravitation, this great philosopher had found that a body which receives an impulse in free space, and is subjected to the attractive force of the sun, will necessarily revolve in a conic section having the sun in the focus. The orbit actually described by the body *may* be either a circle, an ellipse, a parabola, or an hyperbola, but it *must* be one or other of those curves. By a rigorous investigation, founded on Flamsteed's observations of the comet of 1680, Newton discovered that the orbit of that body was a parabola having the sun in the focus. He moreover succeeded in demonstrating that the radius vector of the comet described around the sun equal areas in equal times, conformably to Kepler's second law of the planetary movements. Nor did his researches stop here: he also invented a method by means of which it would be possible from three observations of a comet to determine the elements of its orbit. In this investigation, he supposed the species of orbit described by the comet to be a parabola. His opinion was, that all such bodies revolve in elliptic orbits of great excentricity; but according to the doctrine of conic sections, the curvature of a very excentric ellipse does not sensibly differ from that of a parabola. He therefore adopted the parabolic assumption, which has the advantage of facilitating the solution of the problem.

Newton's method for determining the orbit of a comet, supplied the means of ascertaining *all* the elements if the orbit was a parabola; and all the elements except the major axis if the orbit was elliptic. In regard to the latter supposition, the adoption of which, as already mentioned, accorded with Newton's views, the author of the 'Principia' remarked, "I leave their axes and times of revolution to be determined from the comparison of comets which return in the same orbits after long periods." ('Princip.' lib. iii., prop. xii, 1st edit., 1687.)

Halley, who was one of the earliest supporters of the theory of gravitation, resolved to reduce to practice Newton's ideas on the theory of comets. He accordingly collected together all the recorded observations of those bodies extending down to the year 1700, and with incredible labour calculated the parabolic elements of their orbits in every instance wherein trustworthy data were available for such a purpose. The comets whose orbits were thus calculated amounted to twenty-four in number. They appeared in the following years:—

1337
1472
1531
1532
1556
1577
1580
1585
1590
1596
1607
1618
1652
1661
1664
1665
1672
1677
1680
1682
1683
1684
1686
1698

A comparison of the orbits of the comets of 1531, 1607, and 1682, clearly indicated to Halley that they referred to the same comet. This will readily appear from the following statement of their elements, extracted from Halley's table:—

	Comet of 1531.	Comet of 1607.	Comet of 1682.
Longitude of ascending node	49° 25′	50° 21′	51° 16′
Inclination of orbit . .	17° 56′	17° 2′	17° 56′
Longitude of perihelion .	301° 39′	302° 16′	302° 52′
Perihelion distance, . . that of the earth being 1	0·567	0·586	0·583
Perihelion passage . .	Aug. 24	Oct. 16	Sept. 4
Distance from perihelion to ascending node . .	107° 46′	108° 5′	108° 23′
Motion	Retrograde	Retrograde	Retrograde.

Upon comparing the intervals between two consecutive perihelion passages, it will be found that while for the comets of 1531 and 1607 the interval amounts to 76 years and 53 days; the corresponding interval for the comets of 1607 and 1682 amounts to only 74 years and 323 days. The difference between the two intervals amounts to 1 year and 95 days, or somewhat more than 15 months. But according to the theory of gravitation, a body revolving in an elliptic orbit around the sun in virtue of the attractive force of the latter, ought to return to its perihelion at successive intervals of equal magnitude; or, in other words, ought to perform its successive revolutions in equal times. Halley, however, did not fail to perceive the origin of this apparent discordance. He remarked, in fact, that the disturbing action exercised by the larger planets upon the comet could not fail to accelerate or retard the passage of the perihelion, as the case might be, and would thereby derange the equality in the times of revolution which would otherwise ensue. He found that in the summer of 1681, when the comet was approaching the perihelion, it passed so close to the planet Jupiter that it must have been powerfully disturbed by that body, and he clearly perceived that the effect of such a disturbance would have been to retard the arrival of the comet in the perihelion.

Adopting the interval which elapsed between the perihelion passages of 1531 and 1607, the comet ought to return to the perihelion in November, 1758; on the other hand, the adoption of the corresponding interval between 1607 and 1682 would fix the passage of the perihelion in the month of August, 1757. Halley very sagaciously inferred, from a rough estimation of the effect which would be produced by the disturbing action of Jupiter (for in his time there existed no methods for rigorously calculating the amount of such perturbations), that the comet would not be visible before the end of 1758, or the beginning of 1759; and he appealed to posterity not to lose sight of the fact, that if the comet should really return about the year 1758, the prediction of such a result was due to an Englishman.

The 'Astronomiæ Cometicæ Synopsis,' containing Halley's researches on Comets, was published in the 'Philosophical Transactions' for 1705, and again at the University press at Oxford, and also in an English translation, published in London in 1705, which was reprinted in 1706, in the 'Miscellanea Curiosa.' It was again reprinted in the second edition of Gregory's 'Astronomy;' in an English edition of the same work, 1715; in Le Monnier's 'Theory of Comets;' and was finally left for publication in an augmented form by Halley himself, and was published with his 'Astronomical Tables,' in 1749.

During the period which elapsed between the publication of Halley's researches on cometary orbits, and the time announced for the return of the comet of 1682 to the perihelion, an important step had been made in the application of analysis to physical astronomy. Methods for solving by an approximative process the problem of planetary perturbation were invented, independently of each other, by Euler, Clairaut, and D'Alembert, and were successfully used in computing the inequalities of the moon's motion. As the time fixed by Halley for the return of the comet to the perihelion drew nigh, the subject of its motion, which was calculated to exercise an important influence on the Newtonian theory of gravitation, naturally excited a lively interest throughout every country in Europe. Clairaut undertook the arduous task of computing the effects of planetary perturbation. He was assisted in his calculations by Lalande, who had just commenced his astronomical career, and also by Madame Lepaute, the wife of a well-known watchmaker of the day. The principal disturbing bodies in this case were Jupiter and Saturn. It was found that both planets tended to retard the passage of the comet through the perihelion. According to Clairaut's calculations, he found that the comet would be retarded 518 days by the action of Jupiter, and 100 days by the action of Saturn. Taking these circumstances into consideration, he found that the time of revolution would be 76 years, 211 days; and since the comet had previously passed the perihelion on the 14th of September, 1682, it followed that the next passage of the perihelion would take place on the 13th of April, 1759. Clairaut, however remarked that the omission of many small quantities, which was unavoidable in the treatment of so intricate a question, might cause the real time of the comet's passage of the perihelion to differ as much as a month from the calculated time.

The comet was first observed on the 25th of December, 1758, by Palitsch, an amateur astronomer of Saxony. It passed through the perihelion on the 13th of March, 1759; the time was consequently within the limits assigned by Clairaut. Having revised his calculations, the French geometer found that the error in the computed time amounted to only twenty-two days.

The return of this comet, conformably to the results of calculation, established beyond doubt the truth of Newton's theory of comets, and added fresh lustre to the renown of Halley, by whose name it has since been justly designated. Before proceeding to give some account of the circumstances connected with its perihelion passage in 1835, we shall present the reader with a brief statement of some of the more remarkable comets recorded in history.

371 B.C In this year there appeared a comet of great splendour, which is alluded to by Diodorus Siculus and also by Aristotle. The former of these writers states that the phenomenon was supposed by the inhabitants of Greece to have presaged the destruction of the Achaian cities, Helix and Buris. According to Aristotle, the tail extended over a third of the heavens, or in other words, over an arc of 60°.

134 B.C. Justin states that there appeared in this year a splendid

comet, which continued visible 70 days. The tail is said to have covered a fourth part of the heavens, and occupied four hours in rising.

43 B.C. In this year, during the celebration of the games held in honour of Venus, a great comet appeared at Rome, which was visible before sunset. This celestial prodigy was supposed to have some connection with the departed soul of Julius Cæsar, whose assassination had shortly before occurred.

389 A.D. There appeared a comet, which is said to have almost rivalled Venus in brightness. The tail, which was of immense length, was curved like a scimitar. The apparition of so extraordinary a phenomenon excited universal terror.

891 A.D. Contemporary European writers allude to a great comet which appeared in this year. In the Chinese annals, wherein allusion to it is also to be found, it is stated that the tail was 100° in length.

1106. A great comet appeared, which was visible over all Europe. The tail is said to have resembled a fiery beam. According to Matthew Paris, it was visible in the day-time.

1264. This year was distinguished by the apparition of a magnificent comet, which is alluded to by several European writers, and is also mentioned in the Chinese annals. The tail is said to have attained a length of 100°.

1402. Two comets of extraordinary splendour appeared in the course of this year. The first became visible in the beginning of spring, and towards the close of March was so bright as to be visible in the day-time. The second comet of the year was not less conspicuous than the first, if we are to believe the statements of contemporary writers. The tail is said to have extended from the horizon to the zenith. It is stated, also, as in the case of the first comet, to have been visible in full daylight.

1456. A magnificent comet was visible throughout all Europe. The tail is said to have been 60° in length. The apparition of the phenomenon excited universal terror, in consequence of its being simultaneous with the capture of Constantinople by the Turks. With the view of averting the evil influence of its presence, Pope Calixtus II. ordered prayers to be offered up in all the Western churches; he also, in a famous bull, anathematised at once the Turks and the comet. It has been satisfactorily established in modern times that this was one of the early apparitions of Halley's comet.

1472. The comet of this year was undoubtedly the most splendid of the century. Towards the end of January it was visible in full daylight. In Europe Regiomantanus observed it. In China its successive positions with respect to the stars were also carefully recorded.

1531. An early apparition of Halley's comet. Observed in Europe by Peter Apian, at Ingoldstadt. An account of this apparition is also to be found in the Chinese annals.

1532. A comet appeared this year, which is stated by Cardan to have been visible in full sunshine.

1556. Apparition of a great comet, which has been supposed by some astronomers to be identical with the comet of 1264.

1577. The comet of this year is memorable in history from having furnished the data which enabled Tycho Brahé to demonstrate that the regions traversed by cometary bodies in general lie beyond the moon's orbit.

1607. An apparition of Halley's comet. The phenomenon was observed on the Continent by Kepler and Longomontanus, and in England by the celebrated mathematician, Hariot. The head is said to have equalled in size the planet Jupiter, but to have shone by a pale and watery light. The tail, which was of a very conspicuous brightness, was about 7° long.

1618. The third comet of this year was one of the most splendid of which history makes mention. Longomontanus states that the tail was 100° long.

1652. Apparition of a conspicuous comet, which is minutely described by Hevelius.

1664-5-8. Each of these years was distinguished by the apparition of a comet of considerable brightness.

1680. The comet of this year is, for several reasons one of the most remarkable of ancient or modern times. It was first seen by Godfrey Kirch, at Coburg in Saxony, on the 14th of November. After its passage of the perihelion on the 20th of December, it shone with great splendour, the tail appearing in some places to extend over an arc of 90°. This comet approached nearer the sun than any other comet recorded in history, with the exception of the great comet of 1843. It has been already stated that the observations of this comet furnished the data by means of which Newton was enabled to demonstrate that the orbits of comets are conic sections, having the sun situate in their common focus.

1744. This was the most brilliant comet of the 18th century. It was discovered at Haarlem by Klinkenberg, on the 9th of December, 1743. On the 7th of February the tail was 20° in apparent length. On the 1st of March, when the comet passed the perihelion, it was seen in full daylight. Remarkable physical changes were observed to occur in the head of this comet, on the occasion of its approach to the perihelion.

1759. An apparition of Halley's comet.

1769. This comet is memorable for the immense tail by which it was accompanied. Its passage of the perihelion took place on the 8th of October. On the 10th of September its tail appeared at Paris to be 60°. According to Pingré, the apparent length of the tail in tropical countries measured 97°.

1807. The comet of this year was very conspicuous to the naked eye. It was first discovered at Castro Giovanni in Italy, on the 9th of September, by Parisi, an Augustine monk. The passage of the perihelion occurred on the 19th of the same month. This comet was carefully observed by Sir William Herschel, who, in a paper published in the 'Philosophical Transactions of the Royal Society' for 1808, has recorded many interesting facts respecting it.

1811. The first comet of this year is in many respects one of the most remarkable of modern times. It was discovered by M. Flaguerges, at Viviers, on the 26th of March. The passage of the perihelion took place on the 12th of September. From that time till the end of the year it formed a very conspicuous object in the heavens, the effect being enhanced by the circumstance of its apparent path lying so near the North Pole that it always remained above the horizon. It was last seen in Siberia, by Wisniewski, a Russian astronomer, on the 17th of August, 1812.

1835. An apparition of Halley's comet.

1843. One of the most splendid comets recorded in history. It was seen with the naked eye, close to the sun, in Italy, the Cape of Good Hope, and America, on the 28th of February, the day of its passage of the perihelion. In some places the tail was observed to extend over an arc of 65°. It generally disappeared from observation about the beginning of April. This comet is remarkable for having approached nearer the sun than any other comet of modern times.

1853. A very fine comet appeared in the autumn of this year. Throughout Europe it was distinctly visible to the naked eye shortly after sunset.

1858. The comet discovered by Donati on the 4th of June in this year, is one of the most splendid of which history makes mention. It first became generally visible to the naked eye on the 5th of September. The passage of the perihelion took place on the 30th of that month. The comet attained its greatest slendour about the 10th of October. The tail then appeared to extend over an arc of about 40°. The comet ceased to be visible in Europe about the 20th of October, but it continued to be observed by Mr. Maclear at the Cape of Good Hope till the beginning of March in the following year.

Theory of the Movements of Comets.

The theory of the movements of comets resolves itself into two great subjects of research. One of these relates to the determination of the orbit of a comet from a definite number of observed positions, supposing it to revolve in a conic section around the sun; the other takes cognisance of the effects of planetary perturbation upon its motion. Newton's method for determining the elements of a comet's orbit was founded on the hypothesis of its revolving in a parabola. His opinion indeed was, that all comets revolve in very elongated ellipses; but he remarked, that in any of such cases the orbit near the perihelion does not deviate sensibly from a parabola. By supposing the path of the comet to be parabolic, the investigation of its elements is considerably simplified; but even with this assumption the problem is one of the most difficult in astronomy. It is plain, also, that the parabolic hypothesis cannot assign the major axis of the orbit, nor consequently the time of revolution. Newton, as already stated, remarked that the time of revolution might be found by comparing the intervals which elapsed between the apparitions of comets having the same parabolic elements. For this purpose, it is necessary to form a catalogue of the elements of all those comets the orbits of which have been computed; then, when a new comet has been observed, and its parabolic elements calculated, a reference to the catalogue will serve to indicate whether it has been observed on any former occasion; and if the newly calculated elements should thus turn out to be identical with those of any comet in the catalogue, the interval between the passages of the perihelion will give the time of revolution, supposing the two apparitions to be consecutive. In this way Halley determined the time of revolution of the comet which bears his name; and the same mode of ascertaining the periodicity of a comet is, in consequence of its easy application, constantly practised in the present day. The method most commonly used for computing the parabolic elements of a comet is one invented by the German astronomer Olbers, towards the close of the last century.

It is plain that the determination of the elements of a comet's orbit upon the parabolic hypothesis, is subject to the defect of not giving the major axis by direct investigation. In order to ascertain this element, it is necessary that the comet should have been observed at two consecutive passages of the perihelion. Nay, it may happen that, although the comet has been observed on more than one occasion, the apparitions may not be consecutive; and yet there exists no criterion by which a definitive conclusion on this point may be arrived at. Geometers have accordingly investigated methods for computing the elements of a comet's orbit, independently of any hypothesis with respect to the species of conic section in which it may be revolving. In this branch of research, Laplace and Gauss have laboured with eminent success. According to the method devised by the latter geometer, the six elliptic elements of a comet's orbit may be derived from three (in some cases four) observed positions of the body.

When a comet has once been discovered, three observed positions generally suffice, by the aid of Olbers's method, for ascertaining the parabolic elements of its orbit. If the places calculated from these elements satisfy all the subsequent observed places of the comet within the limits of the errors of observation, or if the observations can be satisfied by any possible correction of the original elements, it may be concluded that the comet revolves in an orbit which is sensibly parabolic. But if the observed places exhibit a systematic deviation from the corresponding results assigned by the parabolic elements, an indication is thereby afforded that the comet really moves in an ellipse or an hyperbola, and the orbit may be investigated *de novo* by means of Gauss's method. In this way the six elliptic elements of a comet may be at once obtained, by a process founded on merely three observed positions of the body.

The earliest general method for computing the effects of planetary perturbation on the movements of comets is due to Lagrange. The process devised by that geometer is founded on the application of mechanical quadratures to the theory of the variation of elements. The orbit of the comet is divided into a number of distinct sections, and the influence of planetary perturbation upon the elements is separately computed for the individual arcs. In applying this process to each arc, fresh elements are obtained which are employed in the computations of the arc immediately following. In regard to many comets, the influence of planetary perturbation is sensible only in the vicinity of the perihelion, and in such cases it is only there that the application of the method becomes necessary. It may be remarked that Lagrange's theory of cometary perturbation has served as the basis of all subsequent researches on the subject.

Periodic Comets.

§ (1) *Comets which have returned to their perihelia since the establishment of their periodicity.*

Halley's Comet.—An account has already been given of the circumstances connected with the perihelion passage of this famous comet in 1759. The next return to the perihelion occured in the year 1835. In 1812, the Academy of Sciences of Turin proposed the investigation of its perturbations as the subject of a prize. Damoiseau, an eminent French geometer, was on this occasion the successful competitor. He found that the comet would pass through the perihelion on the 4th of November, 1835.

In 1829 M. De Pontécoulant obtained the prize of the Academy of Sciences of Paris, for his researches on the same subject. The result of his first investigation indicated that the comet would pass the perihelion on the 7th of November, 1835; but on subsequently taking into account the disturbing action of the earth, and employing more accurate values of the masses of the other disturbing bodies, he found that the passage of the perihelion would take place on the 16th of November.

The perturbations of the comet on the occasion of the same perihelion passage, also formed the subject of elaborate investigations by Rosenberger and Lehmann, two German mathematicians. Rosenberger found that the comet would pass through the perihelion on the 11th of November; according to Lehmann the passage would take place on the 26th of the same month.

It was expected by astronomers that the comet would become visible about the beginning of August. This conjecture received a satisfactory confirmation. The comet was first discovered on the 5th of August, at the Observatory of Rome, by MM. Dumouchel and De Vico. Towards the end of September it became visible to the naked eye. It attained its greatest brilliancy about the middle of October. The head then resembled a star of the second magnitude. The tail exhibited an apparent length of about 20° in the countries of Northern Europe, but in southern climates it was observed to extend over an arc of 30°. The comet was not much seen in the northern hemisphere after the middle of November, having been shortly afterwards lost in the sun's rays. Early in the following year it was seen at the Cape of Good Hope, by Sir John Herschel and Mr. Maclear, and continued to be observed till the 12th of May.

The most complete investigation of the elements of the comet, founded on all the most trustworthy observations made in 1835-6, is due to Westphalen, a German astronomer of great promise, who shortly afterwards died at an early age. In order to exhibit the accordance which existed between theory and observation in this instance, we subjoin the elements of the comet as assigned respectively by Pontécoulant and Westphalen.

	Pontécoulant.	Westphalen.
Passage of the perihelion, M. T. Greenwich . .	1835, Nov. 15·01	1835, Nov. 15·95
Longitude of the perihelion	304° 31′ 42″	304° 31′ 32″
Longitude of the ascending node	55° 10′ 15″	55° 9′ 59″
Inclination	17° 44′ 53″	17° 45′ 5″
Excentricity . . .	0·9672807	0·9673909
Mean distance . . .	18·00008	17·99190

It has been already mentioned that the comet of 1456 was an apparition of Halley's comet. The discovery of this fact is due to the French astronomer Pingré. It has been recently ascertained by the late M. Edward Biot, that a conspicuous comet was observed in China in the year 1378, and M. Laugier has established beyond doubt that this was also an apparition of Halley's comet. The following are tho times of revolution corresponding to the passages of the perihelion which have been deduced from the recorded observations :—

	Years.
1378—1456	77·58
1456—1531	75·21
1531—1607	76·15
1607—1682	74 91
1682—1759	76·49
1759—1835	76·68

The mean of these periods is 76·1 years. The deviations from this result represent the effects of planetary perturbation.

Encke's Comet.—This comet, as in the case of the famous comet of Halley, had been observed on several occasions of its return to the perihelion, before its periodicity was established. On the 26th of November, 1818, a comet was discovered by Pons at Marseille, the parabolic elements of which were soon afterwards found to resemble those of comets observed in 1805, 1795, and 1786. M. Encke was induced by this circumstance to investigate an elliptic orbit for the comets, and he found the time of revolution to be somewhat more than 1200 days. In 1822, on the occasion of its next return to the perihelion, it was rediscovered by M. Rümker, at Paramatta, in New South Wales. Upon tracing back its motion it was found to be in reality identical with the comets of 1805, 1795, and 1786, but a comparison of the earlier with the more recent perihelion passages seemed to indicate that the time of revolution was gradually becoming shorter. Professor Encke was induced in consequence to suspect the existence of a resisting medium, and adopting such an hypothesis, he calculated beforehand the perihelion passage of 1825. The results were found to present a satisfactory agreement with those derived from observation, and on every subsequent occasion of the comet's return to the perihelion, its motion has been successfully computed beforehand by Professor Encke, on the supposition of a resisting medium. The following table, extracted from a paper by Professor Encke, exhibits the gradual shortening of the time of revolution, as indicated by observation. This remark does not apply to the perihelion passages corresponding to the periods 1786-95, 1795-1805, and 1805-19, which were not observed, and are therefore necessarily the results of calculation.

Year of Perihelion Passage.	Time of Revolution in days.
1786	
1789	1212·79
1792	1212·67
1795	1212·55
1799	1212·44
1802	1212·33
1805	1212·22
1809	1212·10
1812	1212·00
1815	1211·89
1819	1211·78
1822	1211·66
1825	1211·55
1829	1211·44
1832	1211·32
1835	1211·22
1838	1211·11
1842	1210·98
1845	1210·88
1848	1210·77
1852	1210·65
1855	1210·55
1858	1210·44

These results indicate that the times of the successive revolutions are gradually shortening at the rate of about $\frac{11}{100}$ths of a day, or somewhat more than two hours and a half. No other comet has hitherto offered any evidence of a similar shortening of the time of revolution. The existence of a resisting medium cannot therefore be considered as established beyond doubt.

It might be supposed that the effect of a resisting medium would be to *lengthen* the time of the comet's revolution, rather than to shorten it as observation indicates. It is true, indeed, that the *direct* effect of such a resistance is to retard the orbital motion of the comet, and *so far* to prolong the time of revolution; but on the other hand, this diminution of the tangential motion allows the central body to act with greater efficacy in drawing the comet towards the centre. Now, according to the theory of central forces, the nearer a body approaches the centre of force the less must be the time of a complete revolution.

The following are the elements of this comet corresponding to the perihelion passage of 1858 :—

Mean longitude	157° 59′ 18″
Ascending node	334° 28′ 34″
Mean anomaly	0° 1′ 48″.0
Inclination	13° 4′ 15″.0
Longitude of perihelion	157° 57′ 30″
Mean daily motion	1074″.05

Available for 1858, Oct. 18·5, Berlin mean time and mean equinox.

Biela's Comet.—This comet was discovered on the 27th of February, 1826, by Biela, an Austrian officer residing at Josephstadt, in Bohemia. Parabolic elements of its orbit were shortly afterwards calculated, and the results are found to bear a strong resemblance to the elements of comets observed in 1805 and 1772. This circumstance induced Gambart, the director of the observatory of Marseille, and Clausen, assisting astronomer at the observatory of Altona, simultaneously to compute elliptic elements of the comet's orbit. The results obtained by those two astronomers presented a satisfactory agreement with each other, and represented the observed places of the comet much better than the elements originally computed. The time of revolution was found to be nearly 6·6 years. Professor Santini of Padua computed the effects of planetary perturbation for the next return to the perihelion. By a discussion of the observations made subsequent to the discovery of the body, he found that it passed through the perihelion on the 18th of March, 1826, and that the corresponding time of revolution was 2455·176 days. Computing, then, the disturbing forces of the Earth, Jupiter, and Saturn, he found that the effect of their combined influence would be to shorten the time of revolution by 10·023 days, and that the comet would consequently pass through the perihelion on the 27th of November, 1832. It is a curious fact, that this comet, a little before its arrival in the perihelion, passes through the descending node of its orbit at only a very short distance from the earth's orbit. Great fears of a collision of the two bodies were consequently entertained, when it was announced as the result of astronomical calculation, that at the instant of the passage of the comet through its descending node on the 29th of October, the earth would be travelling in the same region. However, an exact computation of the earth's motion relatively to the comet had the effect of dispelling these apprehensions; for it was found that, although the comet would pass from the north to the south of the ecliptic on the 29th of October, the earth would not arrive in the same heliocentric longitude before the 30th of November.

The comet, on the occasion of its re-appearance, was first perceived on the 23rd of August by the observers of the Collegio Romano at Rome. Its passage through the perihelion took place within a few hours of the time fixed by the calculations of Professor Santini. The next passage of the perihelion took place in 1839, but the circumstances of its motion being unfavourable for observation, the comet passed unperceived. The results of Professor Santini's calculations showed that the next perihelion passage would take place on the 11th of February, 1846. On this occasion the comet did not pass unobserved. It was re-discovered, independently, on the 28th of November by Professor Encke, at Berlin, and Signor De Vico at Rome. During the interval of its visibility it underwent a singular change, having separated into two distinct fragments which continued to travel together at a distance of 3′ or 4′ from each other. This singular phenomenon appears to have been first unequivocally observed on the 12th of January, 1846, by Lieut. Maury, of the Observatory of Washington, (U.S.). One of the comets was considerably fainter than the other. Both bodies were seen for the last time on the 16th of April, 1846. Professor Plantamour computed the elements of the orbit described by each comet, taking into account the perturbations produced by the Earth, Jupiter, and Mars. The places of the two bodies when computed from these elements, were found to agree very nearly with the observed places. Professor Plantamour determined the mutual distances of the two bodies, and obtained the following results:—

Date.			Mutual Distance.	
1846	February	10	149,820	miles.
„	„	17	153,530	„
„	„	26	156,640	„
„	March	8	157,220	„
„	„	16	155,790	„
„	„	22	154,210	„

The comet was again observed on its return to the perihelion in 1852. The appearance which it presented on that occasion continued to afford evidence of the disruption which it suffered in 1846, both fragments being still visible. Circumstances do not seem to have been favourable for its re-discovery at the time of the perihelion passage of 1859.

Faye's Comet.—On the 22nd of November, 1843, a comet was discovered by M. Faye, at the Royal Observatory, Paris, the observations of which it was found impossible to satisfy by a parabolic orbit. Dr. Goldschmidt was induced by this circumstance to compute an elliptic orbit for the comet, and obtained results which agreed very well with the observed motion. The time of revolution is 2718 days, or 7·44 years. The comet has been re-observed on the occasions of its return to the perihelion in 1851 and 1858.

Brorsen's Comet.—On the 26th of February, 1846, M. Brorsen discovered at Kiel, in Denmark, a small telescopic comet, which was speedily found to revolve in an elliptic orbit, the time of revolution being about 5·6 years. It was not observed on the occasion of the passage of the perihelion in 1851, but it was found at the next return to the perihelion in 1857.

D'Arrest's Comet.—This comet was discovered by Professor D'Arrest, at Leipsic, on the 27th of June, 1851. It was speedily found to revolve in an elliptic orbit, the period being about 6·4 years. The circumstances of the next perihelion passage were calculated by M. Villarceau, of the Imperial Observatory, Paris; and by the aid of an ephemeris, due to that astronomer, the comet was re-discovered at the Cape of Good Hope by Mr. Maclear, on the 5th of Decembe, 1857. The comet continued to be observed till the 18th of January, 1858. During the whole period of its visibility it presented a very faint aspect.

§ (2) *Comets which have been found to revolve in elliptic orbits, but which have not been re-observed since the discovery of their periodicity.*

A considerable number of comets in addition to those contained in the foregoing list, have exhibited traces of a deviation from parabolic motion, and elliptic orbits have in consequence been calculated for them, the results derived from which have been found to satisfy the observations with a greater or less degree of precision. We proceed to notice briefly the results relative to the periodic time which have been obtained for a few of the more interesting of those bodies.

Comet of 1680.—Halley was of opinion that this comet was identical with comets which appeared in the years B.C. 43, A.D. 531, and 1106; and he hence inferred a period of 575 years. Professor Encke, however, has found by an investigation, based upon all the recorded observations, that the most probable value of the periodic time is 8800 years; but he remarks that in consequence of the large probable errors of the data, the observations of the comet may be tolerably satisfied by an ellipse with a period of 805 years, or even by an hyperbolic orbit. The observations of Flamsteed and Newton alone indicate a period of 3164 years.

Lexell's Comet.—This comet was discovered by Messier in 1770. Astronomers having been unable to satisfy the observations by parabolic elements, an elliptic orbit was computed by Lexell, who found the periodic time to be somewhat more than five years. The comet was carefully searched for on the occasion of the next two expected returns to the perihelion, but it was not discovered in either instance, nor has any trace of it been ever since obtained. Lexell endeavoured to account for this curious circumstance by remarking that previous to 1770 the comet had always been invisible, but that having passed very close to the planet Jupiter in the year 1767, it was thrown into a new orbit, and rendered *visible;* and that, in 1779, having again approached very near to the same planet, it was thrown again into a new orbit, and thereby rendered *invisible.* The researches of Lexell were subsequently confirmed by Laplace, but Le Verrier has in recent times called in question some of the data on which they rest.

Comet of 1811.—The orbit of this famous comet has formed the subject of an elaborate investigation by Argelander, who found it to revolve in an ellipse, with a period of 3065 years. This result must be understood, however, as corresponding only to the time of the perihelion passage. Argelander has shown that the disturbing forces of the planets must exercise a very considerable influence on the time of the next perihelion passage. By computing the perturbations up to May, 1827, he found that the time of revolution would be shortened from that cause to the extent of no less than 177 years.

Comet of 1815.—This comet was discovered on the 6th of March, 1815, by the celebrated astronomer Olbers. Bessel subjected the observations to a thorough discussion, when he found the comet to revolve in an ellipse, with a period of 74 years. Taking into account the effects of planetary perturbation, which he found would accelerate its movement to the extent of two years, he finally ascertained that the comet would again arrive in the perihelion in the month of February, 1887.

De Vico's Comet.—On the 22nd of August, 1844, De Vico discovered at Rome a comet which was found to revolve in an elliptic orbit, with a period of about five and a half years. It was carefully searched for at the perihelion passages of 1850 and 1855, but in neither instance has it been discovered.

Peters' Comet.—This comet was discovered by Dr. Peters at Naples, in 1846, and was found by him to revolve in an elliptic orbit with a period of 12·85 years. According to this result the comet ought to have returned to the perihelion in the year 1859, but hitherto it has not been found.

Winnecke's Comet.—On the 8th of March, 1858, Dr. Winnecke discovered a comet at Bonn, which he found to revolve in an elliptic orbit with a period of 5·549 years. He also established its identity with a comet observed in the year 1819. Supposing it to have made seven revolutions since that year, the time of a complete revolution would be 5·541 years, a result agreeing almost exactly with that obtained by a direct investigation of the elliptic elements.

Donati's Comet.—The observations of this famous comet appear to be best satisfied by an elliptic orbit. According to Professor Stampfer of Vienna, the period of revolution is 2141 years. However, until the totality of the observations shall have been subjected to a complete discussion, it will be impossible to arrive at any definitive result on this point.

Number of Comets.

It is impossible to form any opinion with respect to the number of comets which are liable to visit our system. Multitudes of those bodies, whether from their faintness or the circumstances of their movements, will doubtless for ever elude observation. Arago gives the following enumeration of the number of comets whose orbits have been calculated down to the close of the year 1853 :—

7 apparitions of Halley's comet.
14 apparitions of Encke's comet.
6 apparitions of Biela's comet.
2 apparitions of Faye's comet.
46 apparitions of comets revolving in elliptic orbits, or of which two passages of the perihelion may perhaps have occurred.
151 apparitions of comets revolving in parabolic orbits.

The following statement of the progress of cometary discovery during the five years which have elapsed subsequently to the year 1853, will enable the reader to form an opinion with respect to the activity which pervades this department of astronomical science :—

Year.	Number of Comets discovered.
1854	3
1855	1
1856	0
1857	7
1858	6
	17

It is to be remarked that the foregoing list includes four re-discoveries of periodic comets, namely, the re-discoveries of Brorsen's and D'Arrest's comets in 1857, and of Encke's and Faye's comets in 1858.

Dimensions of Comets.

The head of a comet is frequently a body of immense magnitude. The following are some of the results which have been obtained by the aid of micrometric measurements :—

	Diameter of the Head.
The great comet of 1811	1,270,000 miles
Halley's comet (1836)	357,000 „
First comet of 1780	267.500 „
Comet of Lexell, 1770	204,000 „
Donati's comet	100,000 „

Sir William Herschel found the diameter of the envelope of the great comet of 1811 to be no less than 643,000 miles.

The nucleus of a comet, in many instances not distinguishable at all, is generally of inconsiderable dimensions. The following are some results of micrometric measurement :—

	Diameter of Nucleus.
Comet of 1799	373 miles
„ 1807	538 „
„ 1811	2637 „
Donati's comet (October 6, 1858)	800 „

The tail of a comet sometimes attains an enormous length, as the following numbers will show :—

	Length of Tail.
Comet of 1680	96,000,000 miles
Comet of 1769	38,000,000 „
Comet of 1811 (October 15)	100,000,000 „
Comet of 1843	150,000,000 „
Great comet of 1858 (Donati's)	51,000,000 „

Physical Constitution of Comets.

The substance of which a comet is composed appears to be of remarkable tenuity. This has been abundantly proved by the circumstance of the smallest stars being seen through their structure without undergoing any sensible diminution of light. Sir John Herschel, in a paper on Biela's comet, published in vol. vi. of the 'Memoirs of the Astronomical Society,' has mentioned a fact which affords a striking illustration of the translucency of cometic matter. The comet having passed over a small cluster of stars of the sixteenth or seventeenth magnitude, the appearance presented was that of a nebula, partly resolvable into stars. The most trifling fog would have effaced the stars; but in the present instance they still continued to be visible, although the cometic matter interposed between them and the observer must have been at least fifty thousand miles in thickness.

The question whether the nucleus of a comet is in any case a solid body has been often discussed, but no definitive conclusion has been arrived at. The passage of the nucleus of a comet over a star might be supposed to supply a useful criterion for deciding this point, but no instance of the actual occurrence of such a phenomenon has ever been satisfactorily established. Newton was of opinion that the nuclei of comets must necessarily be solid bodies, since otherwise they would in many cases be dissipated in space by the intense heat to which they are subjected on the passage of their perihelia.

But whether the nuclei of comets be solid or not, it is certain that their masses must be very inconsiderable. This is evident from the circumstance of their producing no sensible derangement in the motions of the planets, however near they approach them. In the year 1779 Lexell's comet passed through the middle of the system of Jupiter's satellites, but none of those bodies appeared to be in the slightest degree affected by its attractive force.

Allusion has been made to the great heat which many comets must undergo on their passage of the perihelion. The following table of

perihelion distances will show how near comets in some instances approach the sun :—

Date of Apparition of the Comet.	Perihelion Distance.
1843	475,000 miles
1680	570,000
1689	1,900,000
1826	2,565,000
1847	3,990,000
1816	4,560,000

Newton found by calculation, that the comet of 1680, on its passage of the perihelion was subjected to a heat 2000 times greater than that of red-hot iron. The great comet of 1843, which approached nearer the sun than any other comet recorded in history, must have been exposed to a heat of still greater intensity. Laplace, availing himself of Black's beautiful discovery of the principle of latent caloric, considered that the heat abstracted by the cometic particles in the course of passing into the vaporous state would serve to moderate the effect of the solar heat at the perihelion, and upon this ground he concluded, that the nucleus of a comet is not necessarily a solid body.

When one of the more conspicuous comets is advancing towards the perihelion, it is seen to undergo a succession of changes in the head and tail. These singular phenomena, which are evidently due to the action of the sun, appear to have been first remarked by Hooke in the course of his observations of the comets of 1680 and 1682. The following extract from his observations of the comet of 1682 (an apparition of Halley's comet), will enable the reader to form some idea of the changes to which we refer. It is right to state that the comet passed through the perihelion on the 15th of September :—

"August 26. At seven in the evening I delineated the figure and shape of the comet, exactly like that I saw through my fourteen-feet telescope, which will appear more plain by the fifth figure than I can otherwise well express it.* It had a pretty bright round nucleus, and about that was an atmosphere of thinner light which was terminated towards the sun with a round figure. That part of this halo, or lighter atmosphere towards the sun, was not so bright or radiant as another kind of light which seemed to issue from the nucleus or star both ways at right angles with the axis through the sun, which lighter issuings bent into a kind of parabolic figure, within the former halo or atmosphere, and was terminated within it, and seemed to form, as it were, a second parabolical termination towards the sun, in the apex of which parabola was the bright nucleus, and this brighter parabolic line of light seemed as gross or thick as the nucleus itself. This issued on both sides, but that on the right hand, or the northernmost, was much more conspicuous; insomuch that that on the left hand, or towards the south, was to be seen but sometimes, but that on the other side was very plain and conspicuous, and seemed like a stream of flame blown out of a candle by a blowpipe, ascending or bending upwards, just as such a blown flame of a candle will do, if it be made by a gentle blast. This I remarked very carefully, to see whether I could find, by any succeeding observations, any alteration of the magnitude, figure, brightness, or position, in respect of the comet's axis. These two bright spoutings of flame or light turned or bent upwards from the sun, and after a short space seemed to unite into the axis or middle of the blaze, and form the shape of the outside of a flame of a candle tapering to a point: the fainter part also without it seemed to taper much in the same manner. I saw also several coruscations or flashings of the flame, shooting out to a great distance into the blaze."

Phenomena of a similar nature were remarked by Heinsius in the course of his observations of the great comet of 1744. In more recent times, Halley's comet (1835), and the great comet of 1858, exhibited analogous changes previous to their passage of the perihelion. It has been already stated that Halley's comet passed through the perihelion on the 15th of November. Previous to the 2nd of October, the appearance which it presented was that of a round nebulous disk, with a faint nucleus in the centre. On that evening, however, the nucleus became exceedingly bright, and there was seen to issue from it a cone of light, which first extended a short distance in the direction of the sun, and then bent back as if impelled by some intense force in the opposite direction. This outstreaming cone of light continued to be seen until the 22nd of October, subject however to violent changes when observed from night to night. It is worthy of remark that simultaneously with these changes the tail was observed to increase gradually in length. The phenomena observed during the apparition of the great comet of 1858, were of a still more complex nature than those which characterised any previous comet, but it would be out of place here to enter into any minute details. On the 16th of September there commenced a series of luminous emissions from the nucleus, which continued till the passage of the perihelion at the end of the month. These were followed by a succession of envelopes of a paraboloidal form surrounding the head, and which were seen in greater or less number at the various observatories throughout Europe and America till the disappearance of the comet about the 20th of October.

The development of the tail when a comet is advancing towards the perihelion affords also a striking indication of the action of the sun, although the mode in which it is exerted continues to be involved in great mystery. The following results of micrometric measures of the progress of the tail of the great comet of 1858, executed at the observatory of Harvard College, Cambridge, U.S., will furnish an apt illustration of our remark :—

---

* These drawings are given in Hooke's 'Posthumous Works.'

Date			Apparent length of Tail.	Absolute length of Tail.
1858	August	29	2°	14,000,000 miles
„	September	8	4	16,000,000 „
„	„	12	6	19,000,000 „
„	„	17	4	10,000,000 „
„	„	23	7	12,000,000 „
„	„	24	7	12,000,000 „
„	„	25	11	17,000,000 „
„	„	27	13	18,000,000 „
„	„	28	19	26,000,000 „
„	„	30	22	26,000,000 „
„	October	2	25	27,000,000 „
„	„	5	35	33,000,000 „
„	„	6	50	45,000,000 „
„	„	8	50	43,000,000 „
„	„	10	60	51,000,000 „
„	„	12	45	39,000,000 „
„	„	15	15	14,000,000 „

The shortening of the tail between the 12th and 17th of September is due entirely to the effect of moonlight. To the same cause may be partly attributed the change from the 10th to the 15th of October, but it is no doubt mainly due to the rapid diminution of the brightness of the comet.

Numerous theories of the origin of the tails of comets have been proposed from time to time, but as they are all open to serious objections we do not think that any useful purpose would be served by giving an account of them on the present occasion. It is plain from the observations of the more conspicuous comets, that the tail is fed by the matter raised from the nucleus by the action of the sun. There would appear to be in this case two forces acting upon the cometic particles, independently of the force of gravitation. First, we have indications of a force violently ejecting the particles to a short distance from the nucleus; and secondly, we have equally clear evidence of a repulsive force of great intensity directed upon the comet from the sun, and driving the particles so ejected to an immense distance in space. The most probable view of the nature of these powerful forces is that which attributes them to electrical agency, but no satisfactory theory of the subject has yet been advanced by any inquirer.

COMITIA. Comitium originally signified a place of meeting, as the name imports. Varro,‘ De Ling. Lat.’ l. v., s. 155. Plutarch (‘ Romulus,’ xix.) says that the plain where the Romans met the Sabines, in order to agree on the terms of a treaty, was called “ comitium,” and Niebuhr, ‘ History of Rome’ (i. 291, ed 1851), in narrating the history of the union of the two towns of Roma and Quirium, and accounting for the steps by which the union was effected, mentions the old legend of a place of meeting for the Roman and Sabine kings and senates, called comitium from the fact of its lying between the Palatine and Capitoline hills. Whether it was intended to preserve a record of the old place of meeting, or was simply used as a topographical description must be left to conjecture. The word was retained and applied to a particular part of the Forum, where for many a day the remembrance of the old rivalry was preserved by the two statues of Romulus and Tatius that were erected in it. The plural “ comitia ” denotes general assemblies of the Roman people, convened by the constitutional authority of some magistrate, in order to enact or repeal anything by their suffrages. One set of comitia was named “ calata,” from the old word *calare*, to call or convene (A. Gellius, 15, 27), where the people were summoned to be witnesses to certain solemn acts, or certain things then announced to them.

There were three kinds of Roman comitia :—

1. *Curiata*, so called because the people met and voted in curiæ. Romulus, it is said, divided the whole Roman people into three tribes, and each tribe into ten curiæ, which were subdivided into decads, being, as Niebuhr contends, the same as houses, so that each curia containing 10 houses, the 3 tribes numbered 300 in all. Now, as no houses but those which composed the three ancient tribes were essential parts of the state, in consequence of which the patricians could boast that they alone (*gentem habere*) had a house (Livy x. 8), this division, so essential to the patrician order, was in close connection with it, and therefore, when the political importance of the plebeians rose, the curiæ sank and, except in the continued observance of their sacra, for some years after their political degradation, fell into oblivion. The word curiæ is derived from curare, to take care of or superintend civil and religious affairs (Varro, ‘ De L. L.’ v. 165, and vi. 46); though another and somewhat plausible etymology is that which connects it with the Sabine word Quiris or Curis. (See Smith’s ‘Latin Dictionary,’ *sub verbo.*) Each curia formed a separate community for the celebration of sacred rites, for which purpose a particular priest, called curio, was attached to each curia, and a decurio, or captain and burgess to each decad or house. But all the curiæ were under the superintendence of a curio maximus. A separate place which was also called curia, was assigned to each curia for performing its sacred rites. The members of a curia were called curiales.

There is some obscurity and doubt about the ancient constitution of the curiæ and comitia curiata. However, it seems certain, that the curiæ had the superintendence of sacred matters, that all the public power was united and centralised in the comitia curiata, and that the patrician order must have possessed a great preponderance in them. (See Niebuhr’s ‘ Rome,’ vol. i., ‘ on the Curies.’) In these comitia laws were made or repealed, peace or war declared; (as to treaties of peace, however, see ‘ Dict. of Gr. & Rom. Antiq.’ Comitia, p. 332 b), the affairs of the curiæ and gentes or houses decided, capital crimes judged, and the king as well as the other chief magistrates of the state elected. The place of meeting (comitium) was in the forum, and in its northern corner were the rostra. There was no fixed time for the meeting of the curiæ, but they met as business required, and were held in the presence and under the protection of the priests, their president being the king, or an interrex in the ante-republican times, and some high patrician magistrate, a consul, prætor, or dictator, under the Republic, while none but the populus or the patrician members of the curiæ had a right to take part in these assemblies.

Servius Tullius having instituted the comitia centuriata, and the plebeians becoming powerful through the comitia tributa, the comitia curiata gradually lost almost all political power. However they still passed enactments under the title of leges curiatæ, which, before the institution of the comitia centuriata, denoted every law made by the comitia curiata; but afterwards that term was limited to express a few political rights, still reserved to the latter comitia, particularly that of granting military power (*imperium*) to those magistrates who were elected in the comitia centuriata, which could only confer civil power (*potestas*). Finally, the political influence of the comitia curiata was reduced to a mere formality, and represented, in Cicero’s time, by thirty lictors. Still, a shadow of the old institution was preserved in the continuance of the patrician comitia calata used principally for the adrogationes. Though their political power was lost, the curiæ retained their religious functions till the last times of the republic, and always elected the curio maximus and the flamens. Their number was never augmented, as was the case with the tribes. Before proceeding to the second class of comitia, a few words on the subject of a peculiar authority possessed by the comitia curiata will not be inappropriate, for a more full account of which the reader is referred to Niebuhr’s ‘ Hist ,’ vol. i. ch. 21. The election of the kings was, it is known, in the hands of the curies, but in addition thereto, to this body belonged the conferring the imperium (Cic. ‘ De Rep.’ ii. 13): hence they not only could elect, but they could annul that election: the first it is said was done by the populus, the second by the senate or patres. and to effectuate that second decision, a law was passed by the patres, called by Cicero lex curiata de imperio, and by Livy, auctoritas patrum (Livy i. 17). The conclusion that Niebuhr draws from this identity of the auctoritas patrum, and the lex curiata de imperio is, that the comitia of the curies and the assembly of the patricians were identical.

2. *Centuriata.* Servius Tullius, according to tradition, in order to diminish the power of the patricians, and to elevate the plebeians without giving them any power, made a new division of the Roman people into six classes, which were subdivided into centuries or votes. There has been much dispute about this division and the number of the centuries ; and the controversy scarcely admits of decision, as the ancient writers (Livius, i. 43, Dionys. Halicarn., ‘ Antiq. Rom.,’ i. 19-22, and Cicero, ‘ De Republica,’ ii. 22) are of different opinions. But the nature of the institution is not so doubtful. According to the more probable opinion (that of Dionys. Hal.), the 6 classes contained 193 centuries. The first class consisted of 18 centuries of knights and 80 centuries of those (*ditissimi*) whose fortune amounted to at least 100,000 ases; the second class (*ditiores*) contained 22 centuries, and consisted of those who possessed at least 75,000 ases; the third (*divites*) 20 centuries, and consisted of those who had a property of 50,000 ases at least; the fourth class (*mediocres*) 22 centuries, of those who possessed 25,000 ases at least; the fifth class (*modici*) 30 centuries, of those who possessed 12,500 ases; the sixth class contained but one century of capite censi, that is, persons counted by head and not by estates: they were also called proletarii, or ærarii.

According to this division the Roman people met in the comitia centuriata, in order to vote in centuries on public matters; that is, a decree of the assembly was made by counting the votes of the centuries. As the first class alone contained more centuries than all the other classes together, it may be said that, as Romulus had created an aristocracy of birth by his division of curiæ, so Servius Tullius created an aristocracy of fortune by his new division. In order to prevent that disadvantage, when the plebeians had obtained more power, the century which was to give its suffrages first was appointed by lot. The century upon which the lot fell was called prærogativa. The other centuries voted according to the order of their classes, and were called jure vocatæ. The decision by lot being regarded as a divine omen, the centuriæ jure vocatæ commonly followed the vote of the centuria prærogativa; and thus the power of the first class was balanced in some measure. A contest however sometimes arose whether a matter was to be decided in the comitia centuriata or tributa.

Every Roman citizen in the best sense of the words (*civis optimo jure*) had the right of giving his suffrage in the centuries. The magistrates who were competent to call these comitia were the consul, the prætor in the absence of the consul, and the dictator, or his representative the magister equitum. The magistrate who presided sat on the sella curulis. On holydays (*feriæ*) comitia were not lawful; the days on which they could be held were called dies comitiales. The place of meeting was the Campus Martius, where were placed the septa for the voters, or inclosures into which classes were admitted one after the other, the president's tabernaculum, and the villa publica for the augurs. Before the business began the auspices were taken, and if they were not favourable the meeting was deferred to another day; but if no obstacle appeared, the business was opened with the standing formula, *velitis, jubeatis Quirites?* by reading either the names of the candidates, or the proposition of a law (*rogatio*). Originally they gave their suffrages aloud (*vivâ voce*), but afterwards by tablets, or ballot; which mode of voting was established by the leges tabellariæ, in order to secure the freedom of election. It was not till after a long contest, commenced by the tribune Gabinius, B.C. 140, that the plebeians obtained the protection of the ballot.

As the comitia curiata originally possessed the sovereign power, so, after the time of Servius Tullius, it came into the hands of the comitia centuriata.

In the first place all legislation belonged to these comitia, and the enactments made by them only were called leges (laws), being obligatory upon all the Romans. A *lex* differed both from a decree of the senate (*senatûs-consultum*), and from an enactment of the comitia tributa (*plebiscitum*), which only bound the respective estates of the patricians and the plebs. If a law was to be proposed to the comitia centuriata, it was to be promulgated (*promulgata*), that is, notice of it was to be given on three market-days before the day of assembly. The proposed law being accepted by the people, which they expressed by the term "perferre," was, after being confirmed by oath of the people, engraved on a public tablet and deposited in the ærarium. See Ulpian, tit. i. s. 3, and D 35, 2. 1.

Henceforward all magistrates, both ordinary and extraordinary, were elected at these comitia, as consuls, prætors, censors, decemvirs, and military tribunes. Those who sought for office appeared in a white toga (*toga candida*, and hence they were called *candidati*) before the people on three previous market-days. The candidate who was elected was proclaimed by the præco, or crier; and if this formality was not observed the election was null. Until the magistrate elect entered upon his office he was called "designatus."

The comitia centuriata were also the court for the decision of war, and probably for accepting and confirming treaties, as well as the court of the people (*judicium populi*), for judging public crimes (*crimina publica*) of a grave kind, which were immediately directed against the state or people; as for example, attempts upon the freedom of the people, attempts of individuals to seize on the sovereign power, insult to or the murder of a tribune. Such a crime, which was called crimen perduellionis, was different from the crimen majestatis. (Cicero, 'De Repub.' ii. 36; 'De Legit.,' iii., 4; 'pro Sext.,' 30, 34; and Heinecc., 'Antiq.,' iv. 18, 46, and 47.)

3. The *Comitia tributa* were the comitia wherein the Roman people met and voted according to tribes. The plebeians having acquired considerable power in the state, these comitia achieved their first important victory B.C. 471, by the Publilian law, which secured to them the right of electing the tribunes, and eventually the other inferior magistrates; while their second great power was gained by the law of Valerius Publicola, B.C. 449, which, giving them the right of originating measures, raised their decrees to the same position as a lex, being again extended by the Hortensian law, so that "Plebiscita omnes Quirites tenerent." Neither birth nor fortune gave advantage in these comitia, as was the case in the other comitia. Every Roman citizen who was classed or registered in a tribe was permitted to vote in them. The place of meeting was not fixed, but ordinarily it was the Campus Martius; sometimes also the forum or capitol, or Circus Flamininus. The same minute formalities with respect to the auspices were not necessary as at the comitia centuriata. The assemblies were called by a tribune, who also presided, if tribunes or ædiles were to be elected; but at elections of other magistrates, or if laws were to be made, consuls and prætors also might preside.

Soon after these comitia were established, all inferior magistrates, ordinary and extraordinary, were elected in them, as tribunes, ædiles, quæstors, proconsuls, and proprætors; the election of the pontifex maximus, and of various other religious functionaries, was made in these comitia. They also sat in judgment in certain inferior cases; but for capital punishments the comitia centuriata only had competent authority, and the trial of Coriolanus, as the story has come down to us, must be regarded as an anomaly and an illegal act.

It has been already mentioned that enactments made by the comitia tributa were called plebiscita, and at first bound only the plebeians. But as the power of the plebeians became enlarged by degrees, the plebiscita, after many contests between the plebeians and patricians, were made equal in effect to the leges, by the lex Hortensia, B.C. 288. (Gaius, i. 1.) From this time these comitia possessed the complete legislative power, thoroughly independent of the senate. Accordingly enactments for making war or peace, or granting a triumph, were frequently passed against the will of the senate.

In the later times of the republic, the management of the comitia became an important object both for ambitious aspirants to power, and for those who professed to maintain the rights of the people. Cæsar, after being made perpetual dictator, virtually concluded their authority by himself appointing consuls, and naming half of the other magistrates. Finally, the elections of the comitia became a mere formality.

(Sigonius, *de Antiq. Jur. Civ. Rom.* i. 17.; Nic. Gruchii, lib. iii. *de Comit. Rom. in Thes. Antiq. Rom.*, ed. Grævius, t. i. p. 531, seq.; Dr. Smith's *Dictionary of Greek and Roman Antiquities*, articles "Comitia," "Curiæ," "Lex," "Plebiscitum.")

COMMA, in Music (*κόμμα*), is the difference between two sounds whose ratio is 81 : 80; or, the difference between the major tone, C D ($\frac{8}{9}$) and the minor tone, D E ($\frac{9}{10}$). Practically considered, the comma is the ninth part of a major tone. Ptolemy thought so small an interval inappreciable: Salinas asserts the contrary. Maxwell ('Essay on Tune') agrees with the latter, and gives the following rule for tuning the comma: Obtain G, stopped as the octave to the open fourth string (on the violin), and the difference between that note and the same taken as the greater sixth below the first open string, must be a comma. We refer those who wish to go deeper into this matter to Smith's 'Harmonics.' But the clearest and fullest information on the subject is to be obtained from the 'Théorie Acoustico-Musicale' of M. Suremain-Missery.

COMMANDERY, a species of benefice attached to certain foreign military orders, usually conferred on knights who had done them some especial service. According to Furetière, these commanderies were of different kinds and degrees, as the statutes of the different orders directed. The name of commandery in the order of St. Louis was given to the pension which the king of France formerly assigned to twenty-four commanders of that order. The order of Malta had commanderies of justice, which a knight obtained from long standing; and others of favour, of which the grand master had the power of disposal.

In England, commanderies were the same amongst the Knights Hospitallers as preceptories had been among the Knights Templars, namely, societies of those knights placed upon some of their estates in the country under the government of a commander, who were allowed proper maintenance out of the revenues under their care, and accounted for the remainder to the grand prior at London. At the dissolution of religious houses, in the time of Henry VIII., there were more than fifty of these commanderies in England, subordinate to the great priory of St. John of Jerusalem. A few of these held productive estates, and had even the appearance of being separate corporations, so much so as to have a common seal; but the greater part were little more than farms or granges. The Templars' term of preceptory was as frequently used to designate these establishments as the term commandery. In Germany the provision for the vicars of a cathedral is also called a commandery. (Furetière, 'Dictionnaire Universel;' Tanner, 'Notitia Monastica,' edit. 1787, pref. p. xvii.; Dugdale's 'Monasticon Anglicanum,' last edit., vol. vi., pp. 786, 800.)

The title of commander has also been adopted to designate the second rank of the Knights of the Bath, who are Knights Commanders. [BATH, KNIGHTS OF THE.]

COMMENDAM, from "commenda," a term of the canon law, which, according to its original signification, was applied where the custody of a void ecclesiastical benefice was, during the avoidance, committed by the bishop or other superior to a person who was to discharge the spiritual duties attached to the benefice without meddling with the profits. The person to whose charge these duties were committed was said to hold the benefice *in commendam*. In time, this practice degenerated into an actual perception of the profits, and the device of holding livings *in commendam* was found by the ecclesiastics of the middle ages a useful method of evading the provisions of the canon law against pluralities. [BENEFICE.] By the law of England no benefice can be held *in commendam* without a licence from the crown. This prerogative has been most frequently exercised where the parson of a parish has been made bishop of a see, the revenues of which were insufficient to support the dignity of the station. For the only way to prevent the avoidance of a benefice by promotion to a bishopric, is to grant a licence to retain it *in commendam*, commonly called a *commendam retinere*. This licence is granted before consecration, or before confirmation, in the case of a translation; another kind of dispensation, called a *commendam capere* or *recipere*, enables a bishop to take a benefice after consecration or confirmation. The consent of the patron of the benefice was essential to the validity of a commendam.

Not only dignities and benefices, but headships of colleges and hospitals, might be granted *in commendam*, &c.

Licence to hold *in commendam* might be temporary or perpetual; but the learning on this subject has now become of little practical value; for by statute 6 & 7 Will. IV., c. 77, s. 18, it is enacted, that no ecclesiastical dignity, office, or benefice, shall be held *in commendam* by any bishop (unless he then held the same); and that every *commendam* thereafter granted, whether to retain or to receive, and whether temporary or perpetual, shall be absolutely void to all intents and purposes.

COMMENSURABLE. Two magnitudes are commensurable which have a common measure. The peculiar part of this subject belongs to INCOMMENSURABLES, THEORY OF, and PROPORTION, which see.

COMME'RCIUM EPISTO'LICUM (commerce of letters), a name which was at one time frequently given to published collections of letters, such as were common about the end of the 17th century and the beginning of the 18th. Thus we have the 'Commercium Epistolicum' of Wallis in the second and third volumes of his works (1693 and 1699); that of Kepler (though his name does not appear in the title-page), published in 1718; and that of John Bernoulli and Leibnitz, published in 1745.

But the name by itself is generally understood to apply to the celebrated collection published by the Royal Society in 1712, in vindication of their decision upon the dispute between Keill and Leibnitz as to the right to the invention of the Differential Calculus, or Method of Fluxions. We have not space here to enter upon the subject-matter of the quarrel itself, but only to give some account of the 'Commercium Epistolicum' [referring for the rest to FLUXIONS, METHOD OF].

In the year 1708, Newton and Leibnitz being then both alive, Keill, an astronomer, now better known by his concern in this matter than by his writings or discoveries, inserted in the 'Philosophical Transactions' (No. 317) an article in which he defended Newton against the editors of the Leipsic Acts, who had spoken of Newton's 'Quadratura Curvarum' as a secondary work in comparison of the previous writings of Leibnitz. He asserted that the method of fluxions was first invented by Newton, and that Leibnitz, changing the name and notation, had inserted it in the Leipsic Acts: his words will bear the construction that he conceived Leibnitz to be a plagiarist, but not that of his being an independent inventor. Leibnitz, on the receipt of this volume (March, 1711), complained of the accusation in a letter to Dr. Sloane (then secretary of the Royal Society); reminded him that on a similar accusation having been made a few years before by M. Fatio de Duillier, the Society and Newton himself had disapproved of it; pointed out the dishonourable stigma implied by Keill (whom he presumed to be innocent of all bad intention), and requested the interference of the Royal Society to induce him to disavow the intention of imputing fraud. Keill (in a letter to Dr. Sloane, May, 1711,) denied that he meant to charge Leibnitz with having known the science of Newton by name and notation; but asserted that Newton had explained his Fluxions in two letters to Oldenburg (then secretary of the Royal Society), which were transmitted to Leibnitz; and that the latter either did draw, or at least could have drawn, the principles of Differentials from thence. On this subject he wrote a long detail of what he considered to be the proof of his assertion. Leibnitz, in another letter (December, 1711), complains that the charge was now more open than before; that he and his friends had never contested the independent invention of Newton; and that he appealed to the Royal Society and to Newton himself. The Royal Society accordingly appointed a committee, which collected and reported upon a large mass of documents, consisting mostly of letters from and to Newton, Leibnitz, Oldenburg, Wallis, Collins, &c., &c. Their report was to the effect that Leibnitz was in London at the beginning of the year 1673, from which time to September, 1676 (when he visited London before returning to Hanover), he was in correspondence with Collins and Oldenburg; that when first in London, he was in possession of a differential method, which was no other than that of Mouton; and that he never mentioned any other till he wrote a letter of June, 1677, being a year after a copy of Newton's letter to Oldenburg, of December 10, 1672, had been sent to Paris to be communicated to him, and four years after Collins began to communicate the contents of that letter. Also that by a former letter of Newton, of June, 1676, it appeared that he had been in possession of his Fluxions five years before: that Leibnitz's method is in fact the same as that of Newton, with a difference of name and notation; finally, that Newton being the first inventor, Keill, in asserting the same, had been no ways injurious to Leibnitz. This report, preceded by a large mass of letters or extracts, appeared in the year 1712; and again with a 'Recensio,' &c., prefixed, and some other additions in 1722; this reprint was also issued with another title-page in 1725. It was translated into French, and was also published in a journal at the Hague. Leibnitz only protested in private letters against the injustice of the proceeding: he declared that he would not answer a reasoning so weak; and it appears moreover that he had on his mind an impression that the acrimony excited against him in England was political. He was in the service of the Elector of Hanover, the health of the queen was declining, and many of the men of science were Jacobites.

With regard to the 'Commercium Epistolicum,' and the Report attached, it is obvious that the final conclusion was not to the point. The question was not whether Newton was the first inventor, but whether Leibnitz had stolen the method. The committee did not attempt to prove that Leibnitz had received the letter which was sent to Paris to be sent to Hanover: nor do they formally venture to assert their belief that Leibnitz was a plagiarist; but, with a subterfuge wholly unworthy of them, they conclude that because Leibnitz might have seen Newton's letter, &c., which they could not prove, Keill did him no injustice in asserting the priority of Newton's invention—which was not the matter of complaint. Moreover, they published much of their evidence in the form of extract, and their omissions are not always justifiable. It does not appear on the face of the report itself that Leibnitz knew of the appointment of the committee, or had any opportunity of stating any objections he might entertain to its members, or of furnishing any documents relating to the question under consideration. There runs throughout the extracts a desire of proving Leibnitz guilty of more than they meant positively to affirm. The latter acted wisely in appealing to posterity; for though party feeling long adopted the conclusions of the Report in England, it is now nearly, if not quite, the opinion of those who study the matter, that Leibnitz really was an independent inventor. The contemporary supporters of Newton, and their followers down to the present day, have chosen to regard the committee as a *judicial* body, and their report as a *decision*. But this was not the case. The committee was avowedly counsel for Newton, though the form of their report gave countenance to the mistake just mentioned. Faulty as they were in more points than one, their unfairness was that of advocates, not of judges.

The part which Newton himself took in the matter at the time was not very well known till lately. In the first edition of the 'Principia' (1687), he stated (book ii. Scholium to Lemma 11) that ten years before (the Scholium must probably have been written in 1686 at the very latest) he had communicated *in cipher* a single sentence to Leibnitz as a key to what he informed him was a method of drawing tangents, &c., and that Leibnitz not only wrote in reply, that he had fallen upon a similar method, but actually communicated it, and that he (Newton) found it to be the same as his own, except in notation and symbols. No doubt it was upon the strength of this scholium that Leibnitz confidently appealed to Newton himself: and we might have imagined that the question of the date of this letter would have formed a part of the inquiry. But we cannot find it alluded to: the publication of the 'Principia' is mentioned in its proper place, without a word as to this scholium; nor can we find any allusion to it. We wish we could end here: but we are compelled to add, that this scholium was omitted by Newton in the third edition of the 'Principia' (1725), and its place supplied by another, in which the name of Leibnitz is not mentioned, but an account of what Newton had written to Collins in 1672 begins and ends in nearly the same words. But it must be remembered that between 1687 and 1725, Newton had suffered that illness which perhaps impaired the powers of his mind, and certainly altered his disposition, perhaps even his memory; for in a letter preserved by Raphson, February 26, 1715-16, he gives an account of the letter of Leibnitz differing in several particulars from the printed scholium.

The 'Commercium Epistolicum' will be found complete in Horsley's edition of Newton, accompanied by additional letters extracted from Raphson's 'History of Fluxions,' London, 1715. The appendix contains the additional letters.

An edition of the 'Commercium Epistolicum,' with valuable notes, and the most recent information, has been published by MM. Biot and Lefort, Paris, 1856, 4to. To what precedes we may add the following facts, recently established.

1. The reprint of 1722 contains some small additions and omissions, though it professes to be nothing but a reprint. Some of these alterations are important, and of a highly unfair character. ('Phil. Mag.' June, 1848.)

2. The letter actually sent to Leibnitz has been found among his papers at Hanover, and a draft of it in the archives of the Royal Society. It does *not* contain the mathematical part of Collins's letter of December, 1672, but only the description given by Newton of the character of his results. This makes little difference; because the mathematical part of Newton's letter contained nothing sufficient, and nothing but the like of what had been printed before; but the discovery convicts the committee of extreme carelessness on the most important point. ('Comp. Alm.' 1852.)

3. Sir D. Brewster, by his recent examination of Newton's papers, has found that Newton himself is fully responsible for the contents, both of the 'Commercium Epistolicum,' and the reprint. This has very often been denied.

4. It has recently been proved, both by internal evidence and by the Newton papers, that Newton himself, a fact always strongly denied by his supporters of this century, wrote the account of the 'Commercium Epistolicum,' which appears in the 'Phil. Trans.' No. 342 (1714-15.)

COMMINATION, THE OFFICE OF, a service in the Liturgy of the Church of England. It is called "A Commination or denunciation of God's anger and judgments against sinners," from the Latin word *comminatio*, a threatening or cursing. The Protestants at the Reformation introduced the reading of this comminatory service as a substitute for the ancient and still continued Catholic ceremony of sprinkling the head, and making the sign of the cross on the forehead with ashes, on the first day of Lent, hence denominated Ash Wednesday; but though it is ordered especially to be read on this day, the rubric adds,—"and at all other times as the ordinary shall appoint." From Archbishop Grindall's Visitation Articles, published in 1576, it appears at that time to have been used on four days in the year, namely, on Ash Wednesday, and on the third Sunday before Easter, Whitsuntide, and Christmas. The origin and object of the service will be best explained by the following extract from its commencement. "In the primitive church there was a godly discipline that at the beginning of Lent such persons as stood convicted of notorious sin were put to open penance and punishment in this world, that their souls might be saved in the day of the Lord, and that others, being admonished by their example, might be the more afraid to offend. Instead whereof (until the said discipline may be restored again, which is much to be wished) it is thought good that at this time (Ash Wednesday) should be read the general sentences of God's cursing against impenitent sinners." The form of the commination seems to be derived from Deuteronomy xi. 26–30 and xxvii. 1–26, which was afterwards strictly obeyed, as related in Joshua viii. 33–34, in the solemn rehearsal of a series of twelve curses from Mount Ebal by the Levites, with a response to each by the people. It may be observed that in this commination, the church does not pray that the sinner may be cursed, nor do the people affirm the curse by replying amen. The acts are stated which are cursed by the law, and the people acknowledge its truth. The blessing with which the service concludes was not added until the last revisal of the Prayer Book.

COMMISSARY, an officer who is delegated by a bishop to act in a particular part of the diocese, to exercise jurisdiction similar in kind to that exercised by the chancellor of the diocese in the consistory court of the diocese. A comissary has, generally speaking, the authority of official principal and vicar-general within his limits. An appeal lies from his decisions to the metropolitan. In some dioceses there is a commissary court for each archdeaconry. The commissarial courts were established for the convenience of the people in parts of the diocese remote from the consistory court. A commissary must be learned in the civil and ecclesiastical law, a master of arts or bachelor of law, not under the age of twenty-six, and he must subscribe the Thirty-nine articles (Canon 127).

In Scotland the same classes of questions which in other parts of Europe were arrogated to the ecclesiastical judicatories came under the authority of the bishops' courts while the episcopal polity continued, and subsequently devolved on special judges, who were called commissaries. The four commissaries of Edinburgh constituted the Supreme Commissary Court, which had jurisdiction in questions of divorce, and of declarators of the existence or non-existence of marriage. The district commissaries had the administrative authority of confirming executors to persons deceased, a function resembling the granting of letters of administration in England. By 4 Geo. IV. c. 97, the functions of the provincial commissaries were vested in the sheriffs of the respective counties, who, before the passing of that Act, were usually appointed the commissaries of their districts. By 11 Geo. IV. and 1 Wm. IV. c. 69, the jurisdiction of the commissaries of Edinburgh was vested in the Court of Session.

COMMISSION, in military affairs, is the document by which an officer is authorised to perform duty for the service of the state.

Anciently, in this country, the regular mode of asembling the national army, either to resist an invading enemy, or to accompany the king on a foreign expedition, was by sending a royal command to the chief barons and the spiritual lords, that they should meet at a given time and place with their due proportion of men, horses, &c. properly equipped, according to the tenure by which they held their estates; and these *tenants in capite* appear to have appointed by their own authority all their subordinate officers. But commissions were also granted by our kings to individuals, authorising them to raise men for particular services; thus, in 1442, Henry VI. gave one to the governor of Mantes, by which the latter was appointed to maintain 50 horsemen, 20 men-at-arms on foot, and 210 archers, for the defence of that city. According to Père Daniel, the commission was written on parchment, and, that it might not be counterfeited, the piece was divided by cutting it irregularly, into two portions, of which, doubtless, each party retained one.

Commissions of array, as they were called, were also issued by the crown, probably from the time of Alfred, for the purpose of mustering and training the inhabitants of the counties in military discipline; and in the reign of Edward III. the parliament enacted that no person trained under these commissions should be compelled to serve out of his own county except in the event of the kingdom being invaded. Of the same nature as these commissions of array was that which, in 1572, when the country was threatened with the Spanish invasion, Queen Elizabeth issued to the justices of the peace in the different counties, authorising them to muster and train persons to serve during the war. Those magistrates were directed to make choice of officers to command bodies of 100 men and upwards; and such officers, with the consent of the magistrates, were to appoint their own lieutenants. This privilege of granting commissions to the officers of the national militia continued to be exercised by the lords-lieutenants of counties, the king having the power of confirming or annulling the appointments; and it was made law in the reign of Charles II. It appears, however, that before the Revolution, the lieutenants and ensigns were recommended for commissions by captains of the companies.

In the French service, between the reigns of Francis I. and Louis XIV., we find that the sovereigns reserved to themselves the nomination of the principal commanders only of the legions or regiments, and that the latter were permitted to grant commissions under their own signature and seal to the subordinate officers, who were charged with the duty of raising the troops and instructing them in the use of arms.

In the British regular army, as well as in the navy, all the commissions of officers are signed by the sovereign. In the navy, in the regiment of artillery, and in the corps of engineers and marines, the commissions are conferred without purchase; as also a large proportion of the commissions granted to officers of the line. Those cadets who have completed a course of military education in the Royal College at Sandhurst and pass successfully, are gazetted without purchase. Such is the case also with those who pass their examination before the Military Commissioners very well, and with the sons of officers who have fallen in the service, or in any case which the commander-in-chief may consider merits it. In other cases, gentlemen obtain leave to enter the army by the purchase of an ensigncy, the prices of which, in the different classes of troops, are regulated by authority; and they proceed to the higher grades on paying the difference between the price of the grade which they quit and of that which they enter.

The commissioned officers of a battalion of infantry are as follow: Field-officers—colonel, lieutenant-colonel, and major. Regimental officers—captains, lieutenants, and ensigns. Staff-officers—chaplain, adjutant, quarter-master, and surgeon.

For a statement of the prices of commissions, see 'The Queen's Regulations and Orders for the Army.'

COMMISSION. [Agent; Broker; Factor.]

COMMISSIONERS, LORDS. [Assent, Royal; Admiralty.]

COMMISSIONERS OF BANKRUPTS. [Bankrupt.]

COMMITTEE, of either house of parliament, may be either of the whole House or of a certain number of the members selected from the rest. When the House resolves itself into a committee of the whole House, the Speaker in the Commons, or the Lord Chancellor or whoever else is the ordinary Speaker in the Lords, leaves the chair, and the Chairman of Committees, a salaried officer, being one of the members, who is appointed by the House at the commencement of of every parliament, takes his place. In the Commons the mace, which usually lies on the table, is at the same time placed under it. In a committee members are not restricted to a single speech on the question under consideration, but each may speak as often as he pleases. Another distinction in the Commons was, that the committee divided by the Ayes merely going to the one side of the room and the Noes to the other, instead of one of the two parties going out into the lobby, as in divisions of the House. But the modern practice of publishing the names having become general, there is now no practical difference between the two modes. By the standing orders or established practice of both Houses, there are certain subjects that can only be brought forward in a committee of the whole House. For instance, all measures relating to the Church must be so introduced; and in the Commons all propositions for the grant of money for the public service must be first made in such a committee, called a Committee of Supply; and all propositions for raising the money so granted, by taxes or loans, or otherwise, in another committee of the whole House, called a Committee of Ways and Means. No committee can consider of any matter except that referred to it by the House; nor can a committee adjourn; therefore, when the business lasts more than a day, a motion is made and agreed to that "the chairman do report progress, and ask leave to sit again;" and when the business is concluded, the chairman is directed to report the resolutions, or he may be directed to bring in a bill. No vote of a committee is of any force until it has been reported to the House, and the report received. The Committees of Supply, and of Ways and Means, always meet for the first time immediately after the commencement of the session, and are commonly continued very nearly to its close by leave to sit again being repeatedly granted by the House. Instructions directing, or otherwise to a certain extent controlling, their proceedings, are frequently issued to committees by the House, to which, of course, they are bound to attend. All public bills in both Houses are also considered in committees of the whole House, after the second, and before the third reading. Private bills cannot be introduced into either House, until the petitions of the parties interested for leave to bring them in have been referred to select committees; and every such bill is again referred to another select committee after the second reading. The members of select committees are commonly appointed by the open nomination of each, that is, in effect, by the vote of the House; but those of committees for trying contested elections in the House of Commons are appointed by secret ballot. The investigation of any subject whatever that is brought before parliament may be referred to a Select Committee, and the proceedings of such committees are usually conducted in public; but sometimes a Committee of Secrecy, which takes evidence and deliberates with closed doors, is appointed, when the public safety or other reasons are considered to make that precaution expedient. A committee is generally empowered to summon witnesses, and to call for papers; but no committee of either House can administer an oath. A witness can only be examined on oath at the bar of the House of Lords.

There are some instances in former times of all the members of both Houses meeting together, at the request of one of the Houses, and such a meeting is described as a Committee of the Lords and Commons. What is called a Joint Committee of the two Houses, composed of a certain number of members selected from each, was formerly not unusual. The time and place of meeting were always appointed by the Lords; and the practice was for that House to appoint only half the number of members appointed by the Commons. A joint committee had the power of examining witnesses on oath; a privilege possessed by the Peers, but not by the Commons. It had, however, no power to report anything more than the evidence taken by it, and as the numerical superiority of the members of the lower House gave them an advantage distasteful to the Lords, the custom has sunk into desuetude, and there has been no joint committee during the last century and a half. In cases in which a joint committee would formerly have been appointed, the method that has been taken is for separate committees to be appointed by the two Houses, with power to communicate with each other. (Hatsell's 'Precedents,' and J. E. May's 'Law, Privileges, Proceedings, and Usage of Parliament.')

COMMITTEE OF A LUNATIC. [LUNACY.]

COMMITTEE OF PUBLIC SAFETY, Comité de Salut Publique, the name given to a committee of members of the National Convention, who exercised a dictatorial power in France for about fifteen months, which is known by the name of the Reign of Terror. After the successful insurrection of the 31st of May, 1793, when the Mountain or terrorist party in the Convention gained the victory, by means of the armed multitudes of Paris, over their fellow-deputies of the Gironde party, Robespierre and his friends monopolised all the power of the Committee of Public Safety. "The committee concentrated itself at last in three of its members: Robespierre, who was the real chief, though half-concealed from view; and Couthon and St. Just. There was perfect unanimity among these three down to the moment of their fall; and there is reason to believe that they had resolved to perpetuate their power by establishing a supreme council of three consuls, in which Robespierre would have had the perpetual presidency, with the departments of justice, exterior, and finance; Couthon, that of the interior; and St. Just, the war department." ('Histoire pittoresque de la Convention Nationale,' par un Ex-Conventional, 4 vols. 8vo, Paris, 1833.) After a career in which every step was marked with blood, the national feeling revolted against such a tyranny, some of Robespierre's old associates, whom it is said he was about to sacrifice, impeached him before the Convention, and he and his few friends found themselves alone, without any military man to support them. Even in the Committee of Public Safety, Collot d'Herbois and Billaud Varennes turned against Robespierre. On the 9th Thermidor, July 28, 1794, Robespierre, Couthon, and St. Just were executed.

A reaction had now taken place in the popular opinion, which pursued the agents of the proscriptions at the bar of the Convention, when their former accomplices, being obliged to give them up, endeavoured to throw the whole blame upon them. Many of them were guillotined, and several of them, among whom were Barrière, Collot d'Herbois, and Billaud Varennes, were transported to Cayenne.

COMMODORE (*commendador*), in the royal navy, is the officer commanding a small number of ships of war, when detached for any particular service from the fleet. In the British navy, commodores are of two classes: Those of the first are distinguished by a red, broad, swallow-tailed pendant at the mast-head; those of the second class, by a blue one. The former are considered flag-officers, and rank and command next to a rear-admiral, and are allowed to change their broad pendant from one ship to another as occasion may require. The service rank of a commodore is equal to that of a brigadier-general in the army. The title is sometimes given to the senior captain in a fleet of merchant ships.

In the French service, the commander of a detachment of ships is called *Chef d'Escadre;* and in the time of Louis XIII. the commander-general of the fleet was so called when he had not the rank of admiral.

COMMON LAW. In its most general signification the expression common law denotes the ordinary law of any country; when used in this sense it is called *common*, as prevailing generally over a whole country, in contradistinction to *particular* laws, the operation of which is confined to a limited district. In this sense the phrase is used in many countries which have adopted the civil law. But in England the definition is scarcely applicable, the common law with us comprising many particular laws, confined to districts, such as the law of gavelkind, the laws of stannaries, and the laws of every manor in the country. For in English jurisprudence by the common law is understood that body of customs, rules, and maxims which have acquired their binding power and the force of laws in consequence of long usage, recognised by judicial decision, in contradistinction to the law contained in statutes now extant. The common law is therefore called, in early periods of our legal history, the "lex et consuetudo Angliæ," and at the present day the appellation is always used to denote the "lex non scripta," in opposition to the "leges scriptæ," or statutes. In addition to customs and usages, whose particular origin is unknown, many portions of the common law undoubtedly consist of statutes passed before the time of legal memory, namely, the beginning of the reign of Richard I., and which, though known historically to have been acts of parliament, have no authority as laws in that character, but derive their obligation from immemorial usage, recognised by judicial decision. The provisions of the common law are, however, quite as binding upon the subjects of England as acts of the legislature, being, as already said, impressed with the character of law by force of judicial decisions. In very early times the system of rules which composed the common law was probably wholly traditional. As civilisation advanced, the decisions of the superior courts of justice were recorded, and that became the authoritative evidence of such customs and maxims as formed part of the common law, in precise analogy to the rule of the civil law, that what the emperor had once judicially determined was to serve as a guide in all like cases for the future. In addition to these recorded judgments of the courts, technically called precedents, the treatises of learned men, called by Blackstone "the sages of the law," such as Bracton, Fleta, Britton, Staundforde's 'Pleas of the Crown,' and Coke's 'Commentary upon Littleton,' have long been acknowledged as depositories of the common law. Of the whole system the judges of the superior courts are the expositors; they declare the law by applying its rules and principles to cases which come before them for judgment; but they have no power to add to or vary the law itself.

Learned writers have indulged in much speculation respecting the origin of the common law of England, though Sir Matthew Hale says it is "as undiscoverable as the head of the Nile." It seems, however, to be well ascertained that the customs which in ancient times were incorporated with it, were of compound origin, and introduced at various times in conformity with the political vicissitudes of the country; some being Saxon, others Danish, and others Norman. It is also quite evident, from the adoption of the Roman terms of art and several Roman provisions, that many of the rules and maxims which the common law has adopted were derived from the civil law. The greater part of our modern mercantile law is unquestionably derived from that source. Again, many parts of the common law have gradually arisen from the necessary modification of its ancient doctrines and principles, in order to render them applicable to new states of society produced by enlarged commerce and advancing civilisation. From this cause some branches of our system of jurisprudence, and notably our law merchant, have wholly sprung into existence in modern times. The whole of the law of evidence for instance, now perhaps the most important part of our practical jurisprudence, has appeared as part of the common law so lately as the time of the Commonwealth. But perhaps the most remarkable instance of the flexibility of the common law, and its capacity of adapting itself to circumstances, is presented by the history of our trial by jury, which may be traced through all its gradations, from a rude kind of trial, in which the jury were merely witnesses called from the neighbourhood in order that they might declare the truth to the judge, to the present artificial system, where the jury themselves decide upon the truth of facts by the testimony of witnesses examined before them. On the other hand, many rules and provisions of the common law have wholly disappeared, having either become obsolete from disuse, or been gradually abrogated by decisions of the judges as they became inapplicable to the altered state of society. So great has been the alteration of the common law which these accessions and abstractions have occasioned, that it can scarcely be termed with propriety the same body of laws that it was 600 years ago, unless it be upon the principle upon which Sir M. Hale maintains its identity, namely, that the changes have been only partial and successive, whilst the general system has been always the same, "as the Argonauts' ship was the same when it returned home as it was when it went out, though in that long voyage it had successive amendments, and scarce came back with any of its former materials." (Hale's 'History of the Common Law;' Blackstone's 'Commentaries,' vol. i.; Reeve's 'History of the Law of England,' vol. i.; Hallam's 'Middle Ages,' vol. ii., on the origin of the Common Law.)

COMMON MEASURE, any magnitude which is contained an exact number of times in two other magnitudes. Thus in the case of numbers, 7 is a common measure of 56 and 700. The method of finding the greatest common measure is precisely the same both in the science of arithmetic and in that of concrete magnitudes. The proof may be briefly stated as follows: let A and B be two magnitudes, of which B is the less. Let A contain B m times, with a remainder R, or $A = m\,B + R$. Then it is easy to show that every magnitude which measures (or is contained exactly a number of times in) A and B both, measures m B and $A - m\,B$ or R; and also that every magnitude which measures B and R measures m B and $m\,B + R$ or A. That is, all measures common to dividend and divisor are common to divisor and remainder, and all measures common to divisor and remainder are common to dividend and divisor. Therefore, the greatest of the common measures of either pair is that of the other. Now, carry on the division as follows until there is no remainder, which suppose to happen at the fourth step:—

$$\begin{array}{rll} \text{Let } A = & m\,B + R & R \text{ is less than } B \\ B = & n\,R + R' & R' \quad ,, \quad R \\ R = & p\,R' + R'' & R'' \quad ,, \quad R' \\ R' = & q\,R'' & \end{array}$$

Then R″ measuring itself, and also R′ or $q\,R''$, must be the greatest measure common to both, for nothing greater than itself can measure R″. But the greatest common measure of R″ and R′ has been shown to be that of R′ and R, which has been shown to be that of R and B, which has been shown to be that of B and A.

In the case of two numbers or fractions, a common measure must be found; for two whole numbers it must be a whole number, 1 at least, if not higher; for two fractions it must be a fraction. But in concrete magnitudes the process may continue without end, which indicates that the magnitudes are INCOMMENSURABLES, (which see for proof.) Hence the necessity, in all correct reasoning, of treating concrete magnitudes in the manner laid down in the fifth book of Euclid.

In Algebra the corresponding process does not ascertain the greatest common measure, which depends upon the specific values of the letters; but only the highest common factor, or that which has the highest dimensions. This part of algebra is frequently rendered singularly obscure by the application of the arithmetical word. Thus, though the highest algebraical factor of $a^2 - x^2$ and $a^3 - x^3$ is $a - x$; this last is not the greatest common measure in all cases, as the reader may try by supposing a and x to be 8 and 6.

COMMON PLEAS, COURT OF, one of the superior courts of record, having original jurisdiction over England and Wales in all common pleas or civil actions commenced by subject against subject. It is at present composed of five judges, one of them being chief justice and the other four *puisne* justices.

During the existence of the Aula or Curia Regis, established by the Conqueror in the hall of his usual residence, the palace at Westminster, that tribunal exercised supreme jurisdiction over all temporal causes, which were adjudicated upon by the principal officers of the royal household, often assisted by persons learned in the law, called the king's justiciars. In this state of things, the poorer class of suitors in the common pleas, between man and man, laboured under the heavy inconvenience of either attending the frequent and distant progresses of the court, or of losing their remedies altogether. This evil, as well as the jealousy entertained by the crown of the ascendancy of the chief justiciar, who presided over the whole Aula Regis, occasioned the article in Magna Charta, that common pleas should not follow the king's court, but be held in some certain place. This court of Common Pleas thereupon became gradually detached from the Aula Regis, and assumed its present separate form. It has ever since continued its sittings, without removal from the palace of Westminster or its immediate vicinity, except on a few occasions, in time of plague or contagious disease.

This court has by its constitution, an exclusive jurisdiction in all those actions, which, as they concern the right of freehold or realty, are called real, and on this account it is styled by Coke the "lock and key of the common law." The great mass of real actions have been abolished, and of the only three remaining—dower, right of dower, and quare impedit—this court has still exclusive jurisdiction. The Court of Common Pleas had originally also an exclusive jurisdiction in suits between subject and subject; but in these personal actions the Queen's Bench and Exchequer of Pleas have long exercised concurrent authority.

Before 1830, the appeal from the judgments of this court was by writ of error to the justices of the King's Bench; a vestige of superiority resulting to the latter as constituting the remnant of that Aula Regis from which this court as well as those of Chancery and Exchequer have been gradually carved out. But now by statute 11 Geo. IV. & 1 Will. IV., c. 70, the judgments of this court can only be reviewed by the judges of the other two superior courts of law, forming a court of error in the Exchequer Chamber; the further appeal thence is to the House of Lords.

Besides its ordinary jurisdiction, this court exercises a summary exclusive and final jurisdiction over railway and canal companies, under the statute 17 & 18 Vict. c. 31, and is also a court of appeal from the decision of the revising barristers. [ELECTION.]

The only persons admitted to audience as advocates in the Court of Common Pleas during its sittings in term were, till 1834, serjeants-at-law. [SERJEANT-AT-LAW.] By a royal warrant in April of that year, the right of audience was directed to cease to be exercised exclusively by the serjeants-at-law; and other counsel were to have an equal right with them so to practise there. Doubts having subsequently arisen as to the authority of the crown to abolish the privilege of the serjeants, the act 9 & 10 Vict. c. 57, was obtained to effect that object. (Blackst. 'Comm.,' Mr. Kerr's ed. vol. iii. pp. 29, 44.)

COMMON RECOVERY. [RECOVERY.]

COMMON, RIGHT OF, in law, is the right of taking a *profit* in the land of another in *common* with him, whence the name arises. Such a right enjoyed in exclusion of the owner of the land seems not to be properly common, though belonging to several persons together.

The profits which may be the subjects of common are the natural produce of land (or water, which is included in the legal signification of land); such as grass and herbage, turf, wood, and fish. The commons relating to these subjects are accordingly called common of pasture, turbary, estovers, and piscary. Other things which cannot be called products of land, but rather part of the land itself, as stones and minerals, may also be the subjects of common right. Rights of way and other accommodations in the land of another, though enjoyed in common, do not bear that name, but are called *easements*.

Of all commons, that of pasture is the most frequent. It is the right of taking grass and herbage by the mouths of grazing animals. It differs from that general property, which may exist in the *vesture* or vegetable produce of the land, without any property in the land itself, and which is a corporeal hereditament; whereas all commons are incorporeal, "as appears," says Blackstone, "from their very definition," an incorporeal hereditament being "a right issuing out of a thing corporate, or concerning or annexed to the same." (2 Bl. 'Com.' ch. 3.) The same remark applies to other commons, the subjects of which—as for instance woods and mines—may belong as corporeal hereditaments to one, while the land generally belongs to another.

Common of turbary is the right of taking turf for fuel; and common of estovers is the right of taking *wood* for fuel, and for the repairs of houses, fences, and implements of husbandry. These supplies of wood are called fire bote, house bote (which includes the former), plough bote, and hedge or hay bote. These estovers or botes may also be taken by every tenant for life or years from the land which he himself occupies, but they are not then the subjects of *common* rights.

Common of piscary is the right of *fishery* in rivers not navigable; the right of fishing in the sea and in navigable rivers being common to all the subjects of the realm.

The extent of rights of common depends very much upon the *title* to them. There are four titles on which such rights may be founded; common right (which seems to be nearly the same thing as the common law), prescription, custom, and grant.

The title by common right arose with the creation of manors, when land was granted out in fee to be *held* of the grantor as *lord*. As such grants were forbidden by the statute '*quia emptores*' (18 Edw. I., c. 1), it follows that all commons appendant now existing must have been created before the date of that statute. The law allowed to every such grantee, of course, and of common right, common of pasture, turbary, estovers, and piscary in the *waste* of the lord, or that part of his lands which was neither taken by him into his *demesne* or actual occupation, nor granted out by him to others. These implied rights of common however were allowed no farther than necessity seemed to require, and rights of common thus originating are still confined nearly within their ancient limits. Springing from grants of land, they were considered as inseparably *appendant* to the land, so that they could not be severed from it without extinguishment. The common of pasture was confined to the purpose of maintaining, from seed time to harvest, the cattle of the commoner which were used by him in cultivating his land, and which that land would maintain through the winter, or which were, as the law styled it, *levant* and *couchant* upon it. Horses, oxen, kine, and sheep, used either for tilling or manuring land, were the *commonable* cattle. The land to which the common was appendant must have been originally arable, though the subsequent change of arable into meadow, &c., does not extinguish the right. Common of turbary appendant was confined to the purpose of supplying fuel for the domestic use of the tenant; and so strictly must this right be still confined within its ancient limits, that it must be appendant to an ancient messuage, and no more turves can be taken under it than will be spent in the house. Common of estovers appendant gives, as it gave originally, only the right of taking wood for the repair of ancient fences and houses. Common of piscary appendant was only for supplying the tenant's own table with fish, and it must be still limited to this purpose.

Commons claimed by prescription (which supposes a grant) may be as various as grants may be. A right of common thus founded may be either annexed to land (when it is said to be appurtenant), or altogether independent of any property in land, when it is said to be *in gross*. If common of pasture, it may be for any kind of animals, whether commonable or not, as swine and geese. The number of animals may be fixed, or absolutely unlimited, and they need not be the commoner's own.

Common appurtenant may be severed from the land to which it was originally annexed, and then it becomes common in gross.

The title to common by custom is peculiar to copyholders, and may also give the commoner various modifications of right.

Right of common of pasture may also be claimed because of *vicinage*, or neighbourhood. This is where two wastes belonging to different lords of manors adjoin each other, without being separated by a fence. The cattle lawfully put upon the one common may then stray, or rather are excused for straying, into the other.

The rights of the owner of the soil over which a right of common exists, are all such rights as flow from ownership, and are not inconsistent with the commoner's rights.

Rights of common are conveyed, like all other incorporeal hereditaments, by deed of grant. When they are annexed to land, they will pass with the land by any assurance adapted to transfer the latter.

Rights of common are liable to be extinguished in several ways, and often contrary to the intentions of parties. It is a rule, that if the owner of common appurtenant purchases *any part* of the land over which the right extends, the right of common is *altogether* extinguished; it is the same if he release his right over any part of the land. This unreasonable rule however does not extend to common *appendant*, though that will be extinguished if the commoner becomes the owner of *all* the land in which he has common, and partial extinguishment of the common will follow from acquisition of part of the land. The enfranchisement of a copyhold to which a right of common is annexed extinguishes the right.

The most common mode of extinguishing rights of common in modern times is by inclosure under act of parliament, and these operations have been systematised by the general inclosure acts, under which commissioners have been appointed for the purpose of superintending inclosures, and the process rendered much less difficult and expensive than it formerly was. (See INCLOSURE; also generally on this subject Woolrych, on 'Rights of Common;' Comyn's 'Digest,' tit., Common; and Blackstone's 'Commentaries,' vol. ii. p. 34, Mr. Kerr's edit.)

COMMON, TENANCY IN, is one of the modes in which property may be held by several persons together. It comes the nearest to separate ownership, from which it differs in little else than that the shares held in common are not actually divided or marked out. As to alienation, transmission by descent, and other incidents of property, the law of undivided and of divided shares is the same. From the blending, however, of the shares, there necessarily arises some peculiarity in the mode of their enjoyment. When the profits of the thing held in common are partible (as corn growing in a field), they are generally actually divided among the tenants, and then the property of each most closely resembles separate property. It frequently happens, however, that this cannot be done; in which case the thing held in common must either be used alternately by the tenants (as a horse), or they must join in using it, as tenants in common of an advowson are required by law to concur in presenting to the church.

The shares of tenants in common may be either equal or unequal, and the quantity of their interests may be either equal or unequal. All may be tenants in fee, tenants for a term, &c., or one may be tenant in fee, and another tenant for a term, &c. It is necessary, however, that the possession of all be contemporaneous; successive interests are not a tenancy in common.

A tenancy in common may be created in several ways. If a joint-tenant, or coparcener, aliens his share to a stranger, the latter is a tenant in common with the remaining joint tenant or coparcener. If the sole owner of property aliens an undivided part of it, and retains the rest, the grantor and grantee are tenants in common. As to the words which, in a transfer of property to two or more persons, create a tenancy in common, or a joint-tenancy, many nice distinctions exist in the law. At common law, a conveyance of land to two simply, and without other words, made them joint-tenants, and not tenants in common; except in a few particular cases. (Litt., 283, 284.) This rule of law was founded on the feudal policy, which favoured the mode of holding property in joint-tenancy rather than in tenancy in common, because the former afforded room for the re-union of the property by survivorship (which is the characteristic incident of joint-tenancy) in a single individual, who might more effectually perform the duties belonging to the feudal tenure than several persons among whom the same burden was divided; and it is probable therefore that in the times of feudalism the intentions of grantors were fulfilled by implying joint-tenancy rather than tenancy in common. For a long time past however the courts have endeavoured, whenever they could, to raise by construction tenancies in common rather than joint-tenancies. But a tenancy in common might always be created by express words, and no technical expressions being necessary for the purpose, the courts have been enabled to lay hold of any words in a deed or will which appeared to them sufficiently expressive of a tenancy in common, in order to establish one. The misfortune however is that they have assumed greater latitude in this respect in the construction of wills and uses and trusts, than in the construction of common-law conveyances; so that the same words, as for instance the words "equally to be divided," often have different effects in different instruments.

The Courts of Equity have decided that in certain cases a simple conveyance to two or more makes them in equity tenants in common, and not joint-tenants, unless there is an express declaration to the contrary. This is the rule where a mortgage is made to two or more, and when an estate purchased by two or more is conveyed to them in unequal shares. This doctrine is sometimes in practice found very inconvenient.

A tenancy in common ceases as a matter of course, when the ownership of the several shares exists in a single individual; it can also be destroyed by partition made by the tenants. Any one of the tenants may compel the others, by suit in equity, to make partition of lands or houses held in common, except when the subject is in its nature not partible, as in the case of a living animal for instance.

Notwithstanding its many inconveniences, tenancy in common often occurs, being frequently created by wills and settlements in which property is given by suitable words to classes of persons together, as to children, or to a number of individuals by name. (See Blackst. 'Comm.' vol. 2, p. 186, Mr. Kerr's ed.)

COMMONS are wastes and pastures which have never been exclusively appropriated by any individual, but used in common by the inhabitants of a parish or district. Where extensive common rights exist, the mode of cultivating the inclosed land is greatly affected by it. All the cattle being maintained on the commons for a great part of the year, less land is laid down to grass, and only so much is kept in meadow as will produce hay to feed the cattle in winter weather, and when the commons will not sustain them. The consequence is, that the arable land is not well cultivated, little manure is made in the yards, and the rent is paid by the stock which runs on the commons, and which increases and grows without any expense to the owner. But it is a wasteful disposition of the land. Common pastures are never improved; no one will drain or clear them of weeds, still less manure them. The stock kept upon them is not by any means so numerous as could be kept on the same surface divided and improved. Hence most of the commons and common fields in Great Britain have been divided and inclosed within the last fifty years. Wherever an inclosure has taken place the public has gained, even when the individuals immediately connected with the land may have suffered some loss, by not receiving an equivalent for the profit they had from the cattle which they contrived to keep on the commons.

The soil of commons within a manor belongs to the lord; if there is no manor, it belongs to the king. The herbage belongs in general to the tenants and other inhabitants of the manor or districts, according to fixed rules. Where commons are very extensive there is sometimes no restriction on the number of cattle which may be turned out on them. This is called *common without stint*.

The usual proportion given to the lord for his right in the soil on an inclosure is one-sixteenth. The remainder is divided among those who have a right of common in proportion to the land they possess, and on which their right depends.

Common fields differ from commons, in that they are divided for the purpose of cultivation; but as soon as the crop is off the ground, the cattle of all the proprietors, or of all the parishioners, as the custom may be, have a right of pasture over the whole in common. This system is incompatible with an improved husbandry, and common fields have been very generally divided and inclosed by particular acts of parliament. The General Inclosure Acts of late years have greatly facilitated these inclosures, and the number of common fields is probably not now very great.

COMMONS, HOUSE OF. The object of this article is to present a distinct though compendious view of the history and actual state of the House of Commons as a part of the Imperial Parliament of Great Britain and Ireland. In considering the history of the English borough system, it must be borne in mind that the municipal organisation of the Anglo-Saxons, though not confined to the towns, was best remembered in them; and when after the Norman invasion, the towns became subject to a royal bailiff, who levied taxes almost at his pleasure, of which only a small portion reached the royal exchequer, the oppression was severely felt, and strong efforts were made to relieve themselves from it. Very early the towns, by offering better terms than were obtained from the bailiff, obtained the power of electing their own mayor, or port-reeve. For this purpose charters were granted, and self-governing municipalities were re-formed. It was natural, when the chief object of the assembling of a parliament was taxation, to apply to these municipalities. They represented considerable bodies of people already united for a somewhat similar purpose, and they already raised tolls and imposed several taxes. The original basis of the representation, however, in the time of Edward I., was very different from what we must suppose it would have been made, had the crown and its advisers at that period contemplated in this arrangement any such thing as the composition of a legislative assembly. The very large proportion of the whole number of its members that were sent from the towns, at a period when the population and general importance of the towns, as compared with those of the counties at large, were vastly less than they are now, was manifestly a circumstance repugnant to all the political notions and tendencies of the government of that day. Under Edward I. the town representatives bore so large a proportion to those of the shires as 246 to 74; and under Edward III. as 282 to 74. The reason why, on the first settling of the representative system into regularity and permanency, each constituency was uniformly summoned to elect *two* members, without regard to its known or presumed proportion of wealth or populousness, seems to have been very simple and very natural. So long as the parliamentary voice of the commons was confined to matters of taxation merely, the only thing that appears to have been seriously regarded in fixing the number of delegates was the securing such a delegation from each constituency as at the smallest inconvenience and expense to the latter should have full power to treat of the pecuniary business in question; and *two*, being the smallest number compatible with the important conditions of mutual consultation and joint testimony, was fixed upon as the number that imposed the smallest burden on the constituents, and was also most convenient for avoiding a too crowded assemblage of representatives. And thus it seems to have been that the periodical and frequent shire and borough courts presenting the most natural and convenient modes and occasions of appointing the parliamentary deputies of the several communities, two representatives, and two only, were summoned indifferently from the shire as from the borough, and from the largest shire or borough as from the smallest.

When the power and authority of the commons in parliament had become so firmly consolidated under the first three Edwards as to exercise an effective control over all the great measures of government, the composition of the representative body was an object of constant attention and solicitude to the crown. As the number and names of the counties entitled to send members admitted neither of doubt nor of dispute, the right of the *boroughs* became the first object of attack from that quarter. The parliament having in 1297 (25 Edward I.) procured the passing of the act called "Statutum de tallagio non concedendo," which enacts that "no tallage or aid shall be taken or levied by us or our heirs in our realm without the good will and assent of the archbishops, bishops, earls, barons, knights, burgesses, and other freemen of the land," it became important to influence the borough as the most numerous body.

The great instruments of the crown in influencing the *composition* of the popular representation, especially of the borough portion of it, were, the *sheriffs* of the several counties returning members, of which, in the time of Edward I., there were thirty-seven; Durham and Cheshire having then palatinate parliaments of their own, and Monmouthshire being part of Wales, which was not yet legislatively incorporated with England, nor even effectively subjected to the English crown. It was as the king's *bailiff*, that is, as local superintendent and collector of the crown revenues, that the precepts for election of knights, citizens, and burgesses were addressed to this officer; he was to make returns for every city and borough in his *bailiwick*—another mark of the original purpose for which the popular representatives were convened, that of taxation only. So long as this continued to be the sole object of their convocation, and so long as the delegated burgesses themselves had little voice in fixing the rate of impost to be levied on their constituents, it is not surprising that the smaller boroughs in particular should often have petitioned to be excused from the sending of delegates on these occasions, which added to their share of the public burden, the expense, to them considerable, of the wages which by royal writ they were to pay their representatives during their absence on this parliamentary service, and which were fixed at two shillings each per day, being one half the amount appointed to be paid by the county freeholders on the like occasion to a knight of the shire. As the king's writ addressed to the sheriff specified no particular city or borough, but required him in general terms "to cause to be elected two citizens for each city, and two burgesses for each borough in your bailiwick," a sort of discretionary power seems to have rested with the sheriff of determining what towns were qualified to send representatives. Thus we find the returns made by these officers concluding sometimes with the words "there are no more cities or boroughs in my bailiwick," though there were in fact more boroughs; and sometimes ending with "there are not any other cities or boroughs within the county from which any citizens or burgesses can or are accustomed to be sent to the said parliament, by reason of their decay or poverty." Immaterial as this circumstance in the original framing of the parliamentary writs might appear at the time, its results have been momentous. It must have been remote indeed from the contemplation both of Simon de Montfort and of Edward I., that in convoking so large a number of delegates from towns, in order to tax them with greater facility and uniformity, they were laying the foundation of a separate house of legislature, wherein the representatives of that part of the population most alien to the feudal organisation should vastly preponderate. They evidently looked not so far, nor suspected any latent danger in the generality of the terms in which these precepts were couched. But when the commons came to assert and establish their claim to a full and free *legislative* voice, and it consequently became of the highest importance to the crown to secure to itself any and every means of influencing the composition of that assembly, there was one expedient to which it was too late to resort, that of singling out boroughs for representation, or omitting them at pleasure. The contrary precedent was firmly established—that, through the sheriff, every city and borough was to be summoned; the original terms of the writ were grown into an inviolable constitutional maxim; and in the fifth of Richard II., the Commons were already sufficiently powerful to procure statutory enactments imposing a fine on any sheriff who should not *literally* obey the writ, and subjecting *citizens and burgesses*, as well as others having parliamentary summons, to be "amerced or otherwise punished" for non-attendance. And although notorious inability, from devastation by war or other calamity, to pay the parliamentary wages of representatives, continued long after to be admitted as a valid plea of exemption from electing in the case of individual boroughs, the great principle of the *right* of every municipal town to be summoned, and its *duty* to return members, if capable, was constantly and firmly maintained.

In like manner, statutes were passed in the three following reigns to restrain the corrupt and irregular proceedings of the sheriffs both in county and in borough elections.

Hitherto, however, the parliamentary determinations of the commons, as regarded the constitution of their own house, had constantly tended to maintain the political rights of their constituents against invasion on the part of the crown. But that firm and lasting establishment of their own power as a distinct legislative body, which may be dated from the great revolution that first brought the house of Lancaster to the throne, seems, by that very additional security which it gave them against royal encroachment, to have tended to embolden the house, not, as formerly, to maintain the elective franchise to the utmost with the same zeal with which they upheld their own interest and independence as a legislative chamber, but to commence a sort of reaction against the constituent bodies by narrowing the basis of the suffrage itself. The earliest of these disfranchising enactments, and one of the most remarkable, is that of the 8th Henry VI., restricting the county franchise, formerly possessed by all freeholders, to such only whose freeholds were worth clear forty shillings a year, a sum at least equal to twenty pounds of the present day. The next remarkable instance, though very different in its nature, of legislative enactments respecting the constitution of the commons' house, appears in the parliamentary incorporation of Wales and Cheshire in the reign of Henry VIII., which brought an accession of sixteen county and fifteen borough members.

The *borough* representation in general was still the great object of attention to the Crown in undermining the independence of the House of Commons. The development of that part of its policy was diligently pursued under the later reigns of the Tudors, and carried to the utmost limit by the Stuarts; 1st, by creating or reviving parliamentary boroughs, and at the same time remoulding their municipal constitutions according to the views of the court; 2nd, by proceeding to assimilate the municipal constitutions of the old parliamentary boroughs to those of this newly-created class. The last addition to the English representation previous to the changes made by the Reform Act, was, under Charles II., the enfranchisement by statute of the county and city of Durham, and the creation by charter of the parliamentary borough of Newark. Nor must we forget to mention that James I., by virtue of his royal prerogative, had conferred the right of electing two members upon each of the two universities of Oxford and Cambridge, quite independent of the city and borough representation of those places already existing: thus introducing an anomaly, as well as novelty, into the representative system, a sort of forced alliance between learning and politics, emanating from the peculiar mental constitution and training of that prince.

Those who conducted the revolution of 1688 made much more effectual provision against the return of Roman Catholic ascendancy than they did for the purification of the representative system. The Bill of Rights does, indeed, express, "that the election of members of parliament ought to be free;" but this vague declaration seems to have amounted to nothing more than an indication of the prevailing public opinion on the subject. We find another strong proof that the public attention had now begun to be directed, not merely, as in former times, to upholding the authority of the Commons' House as constituted in parliament, but to the nature of the relations, on the one hand between the house and the constituent body of the nation, on the other between the several members and their individual constituencies, in the enacting of the statute commonly called "the Triennial Act," which deprived the crown of the power of continuing the same House of Commons for a longer period than three years. The Triennial Act of 6 & 7 William and Mary, c. 2, was an enactment wholly on the side of electoral freedom. The discretionary power previously exercised by the crown, not only of dissolving, but of continuing at pleasure, was highly favourable to any such view, on the part of the crown, as that of forming a tacit compact with a corrupt or servile majority of the Commons' House, and was therefore, as had been lately seen under Charles II., exceedingly convenient both to king and commons, when the latter happened to be sufficiently pliant. So strongly, however, was the popular opinion on this point expressed at the period in question, that it compelled the commons to persist in the measure in spite of King William's refusal of assent to the bill after its first passing the two houses, so that on the second occasion his assent was reluctantly yielded. The same activity of the public opinion of that day respecting the composition of the commons, produced the several Acts of that reign which disqualify various classes of placemen for seats in the house.

In this place we must notice the legislative union with Scotland, effected in 1707 by statute 6 Anne, c. 8, only to mention that it brought an accession to the English (which thereby became the British) House of Commons, of thirty members for counties, and exactly half that number for cities and boroughs; exhibiting between the numerical amount of the county and that of the borough representation a proportion quite the reverse, not only of that which existed in England, but of that which had previously appeared in the Scottish parliamentary representation.

The same reign presents us with an enactment of the British House of Commons respecting its own future constitution, totally different in character from those of William III.'s time just referred to. This is the very important Act (9 Anne, c. 5), which established the qualification of landed property for English members, whether for counties or boroughs. In the reign of Henry VI., which gave birth to the enactment disfranchising the smaller county freeholders, was passed an Act, in the same spirit, restricting the choice of those freeholders who still retained the franchise. The very terms of this statute imply, that in the case of the counties, as in that of the boroughs, there was originally no legal distinction between the qualification of the electors and that of the elected, but that the former were simply called upon to return two of their own number according to their own best discretion. The circumstance, too, of the daily expenses uniformly paid under legal obligation by the constituents to each representative while absent on parliamentary duty, may in this place be properly mentioned as a striking evidence of the fact, that the qualification of considerable property, how much soever it might be regarded in the judgment of the constituents, was, originally, not at all contemplated by the law. The statute in question (23 Henry 6, c. 14) declares, that thenceforward the county representatives shall be "notable knights of the same counties, or shall be able to be knights," that is, shall have freehold to the amount of 40*l.* per annum, and that no man shall be eligible "that stands in the degree of a yeoman or under." On this legal footing the county representation remained until the ninth year of Queen Anne, when not only was the landed property qualification re-enacted for the counties on a scale nearly proportioned to the decrease in the nominal value of money, but an unprecedented step was taken, by including in the very same clause of the same Act a provision, that while every knight of the shire should possess a freehold or copyhold estate of clear 600*l.* per annum, so also every citizen, burgess, or baron of the Cinque Ports should have the like landed qualification to the amount of 300*l.* per annum. The statute of the 1st Geo. I., commonly called the Septennial Act, which extended the legal duration of parliaments from three years to seven, how cogent soever might be the political motives of the chief promoters of the measure, is another memorable instance of the lengths to which the House of Commons could now venture in dealing in a wholesale manner with the elective rights of its constituents.

One of the most important operations of the British House of Commons during the period above mentioned, was the enacting of the statute, passed in 1800, and taking effect from January 1st, 1801, by which it incorporated the parliamentary representation of Ireland with that of Great Britain. For the previous history of the Anglo-Irish representation, and the degree of alteration made in it by the Act of Union, we refer to PARLIAMENT OF IRELAND. Sixty-four members for counties, thirty-five for cities and boroughs, and one for Dublin university, were thus added to the number of the British House of Commons. In this instance, as in that of the Scottish union, the ancient proportion between the city and borough representation was reversed, and an additional weight consequently thrown into the scale of the county representation of the United Kingdom at large.

It is needless to encumber our pages with a list of the places now returning members of parliament, since these may be seen, with the names of the members, published annually in a variety of shapes; and it is the less necessary, as a bill for reforming the constitution of the House of Commons is promised to be introduced by ministers in 1860, which will, if carried, in all probability considerably modify the existing arrangements.

Elective Franchise. Counties. England and Wales.—Until the Reform Act, the parliamentary franchise in counties had remained without extension or alteration, as limited full three centuries before by the statutes of the 8th and 10th of Henry VI., the former of which confined the right to such "as had freehold land or tenement to the value of 40*s.* by the year at least above all charges;" the latter to "people dwelling and resident within the county, &c., whereof every man shall have freehold to the value of 40*s.* by the year." In order to render a man a freeholder, and complete his qualification for voting, it was necessary, not only that he should have a freehold interest in his lands and tenements, but that he should hold them by freehold tenure: consequently copyholders, holding by what is technically termed *base* tenure, as well as *termors*, having only a chattel interest in their estates, were excluded from voting. Doubts having been raised as to the right of copyholders, it was expressly enacted by the 31 George II. c. 14, that no person holding by copy of court-roll should be thereby entitled to vote. The Reform Act extends the franchise by admitting not only copyholders, but leaseholders, and even occupiers, under certain limitations; and abridges it in some cases of freeholds not of inheritance, as also in all cases of land situate in a city or borough, and which being occupied by the proprietor would give him a parliamentary vote for that city or borough. In establishing the right to the county franchise, questions of tenure and interest have become of comparatively little importance, except as they are connected with value; for now what is commonly, though improperly, called a tenant at will (that is, from year to year) occupying land of the annual rent of 50*l.* has a right to vote for a county, without reference to the tenure by which the lessor holds the land, or the interest that he may have in it. By 18 Geo. II., c. 18, s. 5, it was enacted, that no person should vote for a county unless he had been for twelve calendar months in actual possession of the rents and profits to his own use, except in particular cases. But by the statute of 1832, by s. 26 it is enacted, that no person shall be registered as a freeholder or copyholder, unless he was in actual possession of the rents and profits for six months previous to the last day of July of the year wherein he claims to be registered. Leaseholders and their assignees, and yearly tenants, must have occupied for twelve months before the same period, except in the cases excepted by the above-mentioned statute of George II. Value, therefore, has now become the criterion upon which, in many cases, the right of voting wholly depends; and in all cases it is a most material subject of inquiry, in order to determine in what character, whether as freeholder, copyholder, leaseholder, or occupier, an elector should make his claim to be registered.

1. If lands or tenements are held at a yearly rent of 50*l.*, bare occupation, as tenant from year to year, is sufficient to qualify; no further interest in the lands, &c., being necessary, and it being immaterial by what tenure they are held. 2. So also is the occupation of lands, &c., of 50*l.* yearly value, as sub-lessee or assignee of any under-lease created originally for a term of not less than 20 years, how small a portion soever of the original term may remain unexpired. 3. The original lessee of a term created originally for 20 years, of lands of 50*l.* yearly value, or the assignee of such term, is entitled to vote in like manner, whether or not he is the occupier of such lands. 4. The occupier of lands of 10*l.* yearly value, as sub-lessee or assignee of any under-lease of a term of not less than 60 years. 5. So likewise the original lessee, or the assignee of such a term of the lands of 10*l.* yearly value, is entitled, whether occupying or not; nor is the nature of the tenure material in any of the above cases; but twelve months' possession previous to the last day of July is required in all. 6. The being seised of an estate—whether of inheritance or for a life or lives—whether freehold, copyhold, or of any other tenure, to the like yearly value of 10*l.*, entitles.

Freehold lands or tenements of 40*s.* yearly value are still sufficient to give a vote in the four following cases:—

1. If it be an estate of inheritance. 2. If not an estate of inheritance, but only an estate for life or lives, if the elector was seised previously to the 7th of June, 1832 (the day on which the act received the royal assent), and continues so seised at the time of registration and of voting. 3. If acquired subsequently to that day, if the elector be in actual and *bonâ fide* occupation at the time of registration and of voting. 4. Or if acquired subsequently to that day, if it came to the elector by marriage, marriage settlement, devise, or promotion to any benefice or any office.

Of freehold or copyhold estates six months' possession, and of leasehold estates twelve months', is required, previously to the last day of July, in the year of registration, except they come by descent, succession, marriage, marriage settlement, devise, or promotion, &c.

Now, also, it has become material to consider how the lands or tenements are locally situated: for if they are freehold within a city or borough, and in the freeholder's own occupation, so as to confer a right to vote for such city or borough,—or if copyhold or leasehold, and occupied by him or any one else so as to give the right of voting for such city or borough to him or any other person,—they cease to qualify for a county vote.

However, by the 16th section of the act, an express reservation is made of all *existing* rights of suffrage possessed by county freeholders, provided they are duly registered according to the provisions of the act itself.

Scotland.—Under George II. enactments were made which rendered the proving of the old forty-shilling votes yet more difficult, so that many more of them disappeared, and at the close of the last century very few remained. Although the Scottish act of 1681 enacted that the right of voting should be in persons publicly infeoffed in property *or* superiority of lands of 40*s.* old extent, or of 400*l.* Scots valued rent, thus making a distinction, it should seem, between property and superiority, yet it was constantly interpreted to mean that superiors, that is, tenants-in-chief, or persons holding immediately of the crown, were *alone* entitled to vote. Thus proprietors of estates, of whatever value, holding from a subject, were excluded from the franchise. It is computed that in several counties nearly one-half the lands were held in this manner, and in the whole kingdom one-fifth of the lands were so held. The class of landholders thus excluded comprised not only the middling and smaller gentry, and the industrious yeomen and farmers who had inherited or acquired some portion of landed property, but also some men of estates worth from 500*l.* to 2000*l.* per annum; while many persons, who had not the smallest actual interest in the land, possessed and exercised the elective franchise. When a person of great landed property wished to multiply the votes at his command, his course was, to surrender his charter to the crown, to appoint a number of his confidential friends, to whom the crown parcelled out his estates in lots of 400*l.* Scots valued rent, and then to take charters from those friends for the real property, thus leaving them apparently the immediate tenants of the crown, and consequently all entitled to vote. This operation being open as well to peers as to great commoners, they availed themselves of it accordingly, thus depreciating or extinguishing the franchises of the smaller proprietors. This legal fraud began in the last century, and was chiefly practised subsequently to the accession of George III. Among the various modes by which it was performed, the most common were by life-rent charters, by charters on *wadset* or mortgage, and by charters in fee. The parliamentary representation of the Scottish counties therefore had, according to the expression of a learned lord, "completely slid from its basis." The total number of county voters, as compared with the number of persons directly interested in the property of the soil, was extremely small, and of these the number of real votes scarcely exceeded that of the fictitious ones.

The basis of county suffrage was, by the Reform Act for Scotland, to be assimilated, as closely as the difference between the modes of possessing and occupying lands, &c., in the two countries would permit, to the system established for England and Wales. While the old class of rights to the suffrage was preserved to the individuals in actual possession of them before March 1st, 1831, provision was made against their perpetuation; while the body of electors newly admitted consisted of owners to the value of 10*l.* a year,—of leaseholders for 57 years or for life, whose clear yearly interest was not less than 10*l.*—of leaseholders for 19 years where such yearly interest was worth not less than 50*l.*,—of yearly tenants whose rent was not less than 50*l.* per annum,—and of all tenants whatsoever who had paid for their interest in their holding an amount not less than 300*l.* The same difference was made as in the English act, between the freeholder and the mere occupier, as to the *six* months' proprietorship required in the former case and the *twelve* months' occupancy in the latter; and the like exceptions from this condition as to the length of possession in favour of cases wherein either ownership or lease came to a person by inheritance, marriage, marriage settlement, "*mortis causâ* disposition," or appointment to any place or office.

Ireland.—The act of union made no alteration in the parliamentary suffrage of the Irish counties. The qualification of a freeholder remained the same as before, a clear annual forty-shilling interest for a life: and as it was customary in Ireland to grant leases on lives, freeholders were thus created whose votes, from their extreme poverty, and consequent inability to discharge their legal obligations to their landlord, were disposable by him as a matter of course. This practice of multiplying freeholds for election purposes merely was carried to an excessive and most mischievous extent, reducing the franchise almost to universal suffrage, among individuals who, by the very instrument by which they were professedly made free, were reduced to the most abject state of political bondage. Thus many of the counties, in choosing their representatives, lay under the absolute dictation of some great territorial proprietor; and there were few in which a coalition of two or three of the principal landowners would not determine the election according to their own wishes. Under these circumstances, the provision of the Roman Catholic Emancipation Act of 1829, which raised the freehold qualification in the counties of Ireland from 40*s.* to 10*l.*, can hardly be regarded as a virtual disfranchisement.

The whole civil organisation of Ireland having been introduced directly from England, and the system of tenures in particular being the same in both countries, the provisions of the Irish Reform Act which have reference to the territorial franchise are more strictly analogous to those of the act for England than those of the Scottish act could well be made, at least in appearance. The existing freehold rights being preserved here, as in the other two divisions of the empire, to their individual possessors, and the 10*l.* freehold franchise being already established by the above-mentioned provision of the act of 1829, the classes of the electors newly created were: 1. The 10*l.* copyholders. 2. Lessees or assignees having a clear yearly interest of 10*l.* in a leasehold created originally for 60 years or upwards, or of 20*l.* in a leasehold of not less than 14 years, whether in their actual occupancy or not. 3. Sub-lessees or assignees of any underlease in either of the two cases just mentioned, actually occupying. 4. The immediate lessees or assignees, and they only, having a 10*l.* yearly interest in a 20*l.* lease, and actually occupying. The like provision is made as in the English act, against any title to the county franchise being derived from any holding whatever that would entitle to vote for a city or borough.

Cities and Boroughs. England and Wales.—The want of any uniform basis of suffrage in the parliamentary boroughs, the endless diversity of the claims to its exercise derived from the various political as well as local influences that had operated upon them in the course of ages,—a diversity which the numerous, various, and often conflicting decisions of election committees of the House of Commons had additionally complicated and confused—was one of the most grievous defects of the old representative system. The generally prevailing custom, too, that the non-residence of borough voters entailed no disqualification, was one of the most serious evils comprised under this head. The Reform Act prepared the way for sweeping off all the claims to the franchise founded on the old and long-abused titles to borough freedom, by establishing a uniform qualification, resting chiefly on the basis of inhabitancy.

It provided, that in every city or borough which shall return members, every male person of full age and not subject to any legal incapacity, who shall occupy, within such city or borough, or within any place sharing in elections with it, as owner or tenant, any house, warehouse, counting-house, shop, or other building, either separately or jointly with any land, of the clear yearly value of not less than 10*l.*, shall, if duly registered, as directed in another part of the Act, be entitled to vote in the election of members for such city or borough; provided always, that no such person shall be so registered in any year, unless he shall have occupied such premises for twelve calendar months previous to the last day of July in that year; nor unless such person, where there shall be a rate for the relief of the poor, shall have been rated to all rates for the relief of the poor made during such his occupation; nor unless such person shall have paid, on or before the 20th of July in the same year, all the poors' rates and assessed taxes due from him previously to the 6th of April preceding; provided also, that no such person shall be so registered unless he shall have resided for six calendar months previous to the last day of July within the city or borough, or within the place sharing in the election, or within seven miles thereof. The premises in respect of the occupation of which any person shall be entitled to be registered as a voter, need not be always the same premises, but may be different premises occupied in immediate succession by such person during the twelve calendar months previous to the last day of July: such person having paid, on or before the 20th of July, all the poors' rates and assessed taxes due before the 6th of April preceding, in respect of all such premises so occupied by him in succession. Furthermore, when any premises in any such city or borough, or place sharing in the election, shall be jointly occupied by more persons than one, each of such joint occupiers shall be entitled to vote, in case the clear yearly value of such premises shall be of an amount which, when divided by the number of such occupiers, shall give a sum of not less than 10*l.* for each occupier. And in every city, borough, or place sharing in the election, it shall be lawful for any person occupying as above specified in any parish or township in which there shall be a rate for the relief of the poor, to claim to be rated; and upon such occupier so claiming, and actually paying or tendering the full amount of the rates, the overseers are to put the name of such occupier upon the rates; and in case such overseers shall neglect or refuse so to do, such occupier shall nevertheless be deemed to have been rated.

The formerly anomalous position of cities and towns which are counties of themselves, as regards the possession of the elective franchise, was rectified by the Act. Such counties of cities and towns are now included, for the purposes of county elections, in the several counties at large, or divisions of counties, in which they are locally situated—with this restriction only as regards freeholds for life;—that no person shall be entitled to vote in the election of knights of the shire, or of members for any city or town a county of itself, in respect of any freehold whereof such person may be seised for his own life, or for the life of another, or for any lives, except such person shall be in the actual occupation, or except the same shall have come by marriage, marriage settlement, devise, or promotion to any benefice or to any office, or except the same shall be of the clear yearly value of not less than 10*l.* It was further provided that in every city or town being a county of itself, in the election for which freeholders or burgage tenants, either with or without any superadded qualification, had previously a right to vote, every such freeholder or burgage tenant should be entitled to vote, if duly registered: but no such person to be so registered in respect of any freehold or burgage tenement, unless he shall have been in actual possession thereof, or in receipt of the rents and profits for his own use, for twelve calendar months previous to the last day of July (except where the same shall have come to him, within such twelve months, by descent, succession, marriage, marriage settlement, devise, or promotion to any benefice or office), nor unless he shall have resided for six calendar months previous to the last day of July within such city or town, or within seven miles of it; —the limits of such city or town a county of itself, being, for the purposes of this enactment, those settled by the general parliamentary Boundary Act for England and Wales. Similar provision as to length of occupancy, &c., is made in the case of persons having a previous freehold qualification to vote for any of the boroughs of Aylesbury, Cricklade, East Retford, or New Shoreham.

Such are the provisions which constitute what is popularly called, by reference to their most prominent feature, "the ten-pound householder qualification."

But as in the settling of the places which were thenceforward to elect, and in apportioning the members, the new Act made a large compromise with the old system, so also it made no inconsiderable one, for a season at least, in sparing to a certain extent the rights to the parliamentary franchise grounded on the old titles to borough freedom. In all such cases, however, it imposed the very important condition of residence. It provides that every person who would have been entitled to vote in the election of members for any city or borough as a burgess or freeman, or in the city of London as a freeman and liveryman, shall be entitled to vote if duly registered; and that every other person having, previous to the Act, a right to vote in the election for any city or borough by virtue of any other qualification than those already mentioned, shall retain such right so long as he shall be qualified as an elector according to the usages and customs of such city or borough, or any law in force at the passing of the Act, and shall be entitled to vote if duly registered; but in both of the above cases it is enacted that no such person shall be so registered unless he shall, on the last day of July, be qualified in such manner as would entitle him then to vote if such day were the day of election; nor unless for six calendar months previous to that day he shall have resided within such city or borough, or within seven miles from the place where the poll shall heretofore have been taken, or, in the case of a contributory borough, within seven miles of such borough. As regards the second class of voters last mentioned, it is further enacted that every such person shall for ever cease to enjoy such right of voting if his name shall have been omitted for two successive years from the register of parliamentary voters for such city or borough, unless he shall have been so omitted in consequence of his having received parochial relief within twelve calendar months previous to the last day of July in any year, or of his absence on naval or military service.

The expedient to which, to serve party purposes during the agitation of the Reform measure, many of the governing bodies of corporations had resorted, of admitting unusually large numbers of freemen, occasioned the following limitations of the above reservation of the elective franchise of freemen to be introduced into the Act, namely: That no person who shall have been elected, made, or admitted a burgess or freeman since March 1st, 1831, otherwise than in respect of birth or servitude, or who shall hereafter be so, shall be entitled to vote; that no person shall be entitled as a burgess or freeman in respect of birth, unless his right be originally derived from or through some person who was a burgess or freeman, or was entitled to be admitted as such, before the said 1st of March, 1831, or from some person who since that time shall have become, or shall hereafter become, a burgess or freeman in respect of servitude; and that no person shall be entitled to vote for any city or borough (except it be a county of itself) in respect of any estate or interest in any burgage tenement or freehold which shall have been acquired by such person, since the same 1st of March, 1831, unless it shall have come to such person previously to the passing of this Act, by descent, succession, marriage, marriage-settlement, devise, or promotion to any benefice or office.

It also provided in general, that no person shall be entitled to be registered in any year as a voter for any city or borough who shall, within twelve calendar months previous to the last day of July in that year, have received parochial relief or other alms which, according to the previously existing law of parliament, disqualified from voting.

Scotland.—Owing to the previous absence of all popular suffrage in the Scottish boroughs, the revolution made in their parliamentary constituencies by the Reform Act of 1832 was effected simply, completely, and at once. The franchise was taken from the members of the town councils and their delegates, in whom as such it was before exclusively vested, and a 10*l.* qualification, by ownership or occupancy, substituted in its place, with the like conditions, as in the English Act, of twelve months' previous occupancy, payment of assessed taxes, registration, and non-receipt of parochial relief.

Ireland.—In the Irish cities and boroughs, the change immediately worked by the Parliamentary Reform Act was relatively greater than in England, owing chiefly to the fact that the municipal corporations of the former country existed in a state yet more thoroughly anomalous and corrupt than those of the latter. Here, again, the actually existing and the inchoate titles to the parliamentary suffrage being reserved, as in the English Act, on condition of residence within seven miles, and honorary freemen created since March 30, 1831, being excluded, the 10*l.* ownership or occupancy qualification was established as the new basis of suffrage, on condition of registration with *six* months' previous occupancy and payment of all rates due for more than one half-year. Reservation was also made, as in the English boroughs, of rights by freehold under 10*l.*, when accruing before the passing of the Act, by descent, marriage, &c. The clause of the Catholic Emancipation Act, which raised the freehold qualification in counties at large to 10*l.*, left it at the old amount of 40*s.* in the several counties of cities and towns; but the Reform Act raised it there to the same scale as in the counties at large (only reserving for life the existing 40*s.* rights), and at the same time gave the parliamentary franchise for such corporate counties to the same classes of leaseholders, and on the same conditions, whom it admitted in the counties at large.

Universities.—In the two English universities the parliamentary suffrage is independent of residence, property, or occupancy, being vested in the doctors and masters of arts of Cambridge and Oxford respectively, so long as they keep their names on the boards of their respective colleges. In the University of Dublin, in like manner, it is possessed by the fellows, scholars, and graduates of Trinity College, on the like condition.

The establishment of a general and uniform system of registration of voters, calculated to obviate much of the inconvenience of contested returns, is another very important feature of the Reform Acts; for the various and rather complicated details of which we must refer the reader to the Acts themselves.

Having thus given a view of the qualifications for exercising the parliamentary franchise as now established throughout the British Islands, it remains to notice the principal of those legal disqualifications which are of a personal nature, and operate independently of all proprietorship or occupancy.

Every woman, of whatever age, and however independently situated as to property and social relations, is as much excluded from voting as from being elected. As to age in male persons, the only exception is that which excludes all minors; that is, all who have not completed their twenty-first year. The exception which regards *aliens* is so natural and obvious that the bare mention of it may here suffice, as this is not the place in which to examine the various difficulties that in many cases have arisen, and still arise, in strictly defining who are aliens and who are not. By the ancient "law of parliament," which forms an integral portion of the common law, lunatics are very reasonably incapacitated, as also are paupers in city or borough elections. It was resolved by the House of Commons in 1699 (14th December), that "no peer of parliament" has a right to vote for members of that house. After the Union with Ireland, this resolution, which was usually repeated at the beginning of every session, was altered into the following form: "That no peer of this realm, except such peer of that part of the United Kingdom called Ireland as shall for the time being be actually elected, and shall not have declined to serve, for any county, city, or borough of Great Britain, hath any right to give his vote in the election of any member to serve in parliament." The vast increase, since the commencement of the last century, owing to the establishment of so many new branches of revenue, in the number of persons employed immediately by the crown as revenue-collectors, occasioned the enactment of several statutes of exclusion from the parliamentary franchise. Thus the 22nd George III. c. 41, excludes every class of officers concerned in the collection or management of the excise, customs, stamp duties, salt duties, window and house duties, or in any department of the business of the post-office. By 3 George IV. c. 56, s. 14, it was first enacted that no justice, receiver, surveyor, or constable, appointed by that Act at any one of the eight police-offices of the English metropolis, shall be capable of voting for Middlesex, Surrey, Westminster, or Southwark; and by 10 George IV. c. 44, which established the new system of police in certain districts of the metropolis (the operation of which has since been extended to meet the local extension of the police system), it was enacted that no justice, receiver, or person belonging to the police force appointed by virtue of that Act, shall be capable of voting for Middlesex, Surrey, Hertfordshire, Essex, or Kent, or for any city or borough within the metropolitan district. Persons legally convicted of perjury or subornation of perjury, or of taking or asking any bribe, are thereby for ever incapacitated from voting.

As regards religious grounds of disqualification in general, it should be observed, that as no oaths are now required to be taken, nor declarations to be made, as a preliminary either to registration or to voting, all such disabilities as might have arisen from refusal to take or make them are of course removed.

Qualifications of Candidates and Members.

Of the close relation so long subsisting between the grounds of the elective franchise and of eligibility to be elected, and which had sprung from their original identity, we find distinct traces in the similarity between the heads of disqualification in either case. Women, minors, aliens, and lunatics are, of course, excluded in the latter case as well as the former. It would be needless to remark, that peers of *parliament*—that is, actual members of the House of Lords—are ineligible to the House of Commons, except in order to point out this distinction: that any Irish peer, not being among the twenty-eight sitting in the House of Lords for the time being as representatives of the Irish peerage, and being, therefore, though a peer of the realm, not a peer of parliament, is eligible to represent any constituency in the United Kingdom, although such is not the case with Scotch peers who are not representative peers. No person concerned in the management of any duties or taxes created since 1692 (except commissioners of the Treasury), nor any officer of the excise, customs, stamps, &c., nor any person holding any office under the crown created since 1705, is eligible. In like manner, pensioners under the crown during pleasure, or for a term of years, are wholly excluded. Any member, however, who accepts an office of profit under the crown existing prior to 1705, though he thereby vacates his seat, is capable of being re-elected. Contractors with government are ineligible; and it is enacted, that if any person so disqualified shall sit in the House, he shall forfeit 500*l.* per day for so doing; and that if any person having a contract of this nature admits a member of the House to share in it, he shall forfeit 500*l.* to the prosecutor. Again, by 3 Geo. IV. c. 55, no police justice of the metropolis can sit in parliament.

The twelve judges for the time being are disqualified, though, as judges, they are occasionally summoned to, and sit in the House of Lords, but have merely a *consultative* voice there. The vice-chancellor, and the master of the rolls, the judges of the Admiralty, Probate, and Matrimonial Causes courts, and those of the County courts, are also excluded. The exclusion of ecclesiastics from seats in the Commons' house, seems not only to have been a natural result of the presumed urgency of their pastoral duties, but to have reference to the period when their share of those general contributions to the extraordinary exigencies of the state, the business of settling which, as we have already seen, first gave form and consistency to the parliamentary representation in general, was yielded by them as a distinct body. Sheriffs of counties, and mayors and bailiffs of boroughs, as being themselves returning-officers in parliamentary elections, are ineligible for the several districts respectively for which it is their duty to make returns.

The repeal of the Corporation and Test Acts in 1828, and the passing of the Catholic Emancipation Act in 1829, have worked one very important alteration in the constitution of the Commons' House, by removing nearly altogether the widely-operating religious disqualifications which previously existed. The engagement, "on the true faith of a Christian," which the latter act substituted for the oath and declaration formerly required, had no effective operation, except against individuals of the Jewish race and creed. This may now be dispensed with in consequence of the passing of the act, 21 & 22 Vict., c. 49, by a resolution of the house of commons, and Jews now sit in the house.

The property qualification for an English, Welsh, or Irish member was continued by the Reform Acts, namely, for a county member an estate of 600*l.* a year, and for a city or borough member, of 300*l.* The only personal exceptions from this condition were in favour of the eldest sons of peers or of bishops having seats in the House of Lords, and the eldest sons of persons legally qualified to be county members. As regards the Scottish part of the representation, it is worthy of especial remark, that the property qualifications enacted for England within a very few years after the union with Scotland, had never been extended to the latter portion of the kingdom; and that consequently the conditions of suffrage and of eligibility have remained there according to the original constitution of the representative system in both countries, one and the same, excepting only the anciently essential condition of *residence*, which has long been done away with throughout the United Kingdom without any reservation or limitation whatever; and excepting also that the Scottish reform act of 1832 rendered unnecessary for county members the qualification of an elector formerly required. By the act 21 Vict., c. 26, passed on the 28th of June, 1858, all the acts requiring any property qualification in members of parliament were altogether repealed.

Issuing of Writs for a General Election; Election Proceedings and Returns.

An essential and very important part of the representative machinery is that which regards the due transmission from the central to the local authority of the summons to elect, the superintendence of the election proceedings, and the due return from the local to the central authority of the names of the individuals chosen. When the Lord Chancellor, the highest officer of state, has received the written command of the sovereign in council for the summoning of a new parliament, he thereupon sends his warrant or order to the highest ministerial officer acting under him, the clerk of the crown in chancery, to prepare and issue the *writs*, or written authorities for that purpose, to the several sheriffs, whether of counties at large or of counties corporate.

In the early periods of our history, when the shire-motes, or county courts, were held regularly once a month, and the borough courts once a week or once a fortnight, there was no need to incur the trouble and inconvenience of a special meeting of the members of those courts, that is, of the freeholders in the former case and the burgesses in the latter to elect the parliamentary representatives; and accordingly the sheriff was simply required to cause the election of the county members at the next county court, held in the regular course, or at an adjourned meeting of that court, in case such adjournment were necessary in order to allow time for giving due notice of the election. It was not until the importance of the county courts declined, that a different arrangement became necessary; nor was it until the 25th of George III., that it was enacted that the sheriff, on receipt of the writ, should call a *special* county court for the purpose of the election.

The writ, thus addressed under the great seal to the sheriff of a county at large, requires him not only to cause the election of the county representatives, but also of those of each city and borough within his jurisdiction. And accordingly, on receiving this command, he issues a *precept* under his own seal to the head of each municipality enjoying the elective franchise, which precept is to be returned to him within a limited time, together with the name of the person or persons chosen;* in like manner as he himself is bound to return, before a certain day previous to that on which the parliament is summoned to assemble, to the clerk of the crown, from whom he received it, the writ, with the names of the persons chosen, whether as county or as borough members. Such, in brief, as regards the returning-officers and responsible conductors of elections, has been the system from the commencement of the general representation.

In the parliamentary boroughs which had already a municipal or other chief civil officer or officers in whom this function could be appropriately vested, it is so entrusted by the Reform Act. As regards the others, it is provided, that the sheriff of the respective counties shall, in the month of March in each year, by writing under his hand, to be delivered to the clerk of the peace for that county, within a week from its date, and be by him filed with the records of his office, appoint for each of such boroughs a fit person resident therein to be the returning-officer until the nomination to be made in the March following. In case of such person's death or incapacity from sickness or any other sufficient impediment, the sheriff, on notice thereof, is forthwith to appoint in his stead a fit person, resident as aforesaid, to be the returning-office for the remainder of the year. No person so nominated as returning-officer shall, after the expiration of his office, be compellable thereafter to serve again in the same office. Neither shall any person in holy orders, nor any churchwarden or overseer of the poor, be so appointed; nor shall any person so nominated be appointed a churchwarden or overseer during the time he shall be such returning-officer. Any person qualified to serve in parliament is exempted from such nomination as a returning-officer, if within one week after his receiving notice of such appointment he make oath of his qualification before any justice, and forthwith notify the same to the sheriff. In accordance, however, with all previous usage, it is provided that "in case his majesty shall be pleased to grant his royal charter of incorporation to any of the said boroughs named in the schedules of the Reform Act, which are not incorporated, and shall by such charter give power to elect a mayor or other chief municipal officer for any such borough, then and in every such case such mayor or other chief municipal officer for the time being shall be the only returning-officer for such borough; and the provisions hereinbefore contained with regard to the nomination and appointment of a returning-officer for such borough shall thenceforth cease and determine."

The division of both counties and boroughs into convenient polling-districts,—the shortening of the time of polling in contested elections, from the old period of fifteen days to one day in England, Wales, and Scotland, and to five in Ireland,—the restriction of inquiry at the poll into the elector's right to the ascertaining the identity of name and qualification with those contained in the register of voters (thus abolishing the old tediously litigious practice of election scrutinies),—and the limitation of the necessary expense of election proceedings, borne by the candidates or their proposers,—are among the more important of the recent improvements.

Having thus given, we believe, a tolerably just though succinct view of the history and present state of the representative system of the British empire, so far as it can be distinctly shown without continual reference to the other branches of the legislature, we refer for an account of the organisation and operation of the Commons, "in parliament assembled," to a subsequent volume of this work. [PARLIAMENT, IMPERIAL.] There too may be the fit occasion for offering some indications of the future changes in the relative position of the House of Commons as a branch of the legislature, to which the alterations in its internal constitution commenced in 1832 must eventually lead. A word as to the progress of this internal revolution itself must conclude the present notice.

We have seen how the popular representation arose, first as a convenient, then as a necessary appendage to the feudal parliament of the Anglo-Normans. We have seen how, as early at least as the parliamentary settlement of the crown upon the house of Lancaster, that popular representation, under the title of the House of Commons, had become an effective, integral, independent, and solemnly recognised branch of the legislature. We have traced, from that period downwards, the twofold operation, of the crown in undermining this equal and sometimes preponderating independence of the Commons' House, and of that House itself in contracting the limits and abridging the rights of the constituent bodies, until the original constitution of the representative body itself was absolutely subverted. And last of all we have seen that which, in the present day, it is most interesting to consider,—the re-action of an enlarged and enlightened public opinion on the legal constitution of the house. In an historical view it is far less important to examine the merits of the measures of representative amelioration in detail, than to mark the maturity of a new political element which they indicate, and the new line of constitutional progression which they commenced. No matter that the Reform Acts, as they are called, made but a compromise with the exceeding corruptions and anomalies of the old system, and left some of them untouched; no matter that the Commons' House, which in the days of its pristine vigour was democratic in the fullest sense of the term, is still, though somewhat popularised by the recent changes, a highly aristocratic body: we do not the less find in these changes a successful effort of the national intelligence and will, not so much to replace the legislative representation on the basis on which it stood at the close of the 14th century, and which, from the causes we have previously stated, was fixed without any scientific or symmetrical proportioning even of the number of representatives to that of constituents, but to mould it into some shape more accordant with the present advanced state of general information in the great body of the people; to render it, in short, a popular representation in fact as well as in name.

COMMONS, IRISH HOUSE OF. [PARLIAMENT OF IRELAND.]

COMMONS, DOCTORS'. [DOCTORS' COMMONS.]

COMMUNION (the Latin *communio*, the Greek *κοινωνία, koinónia*) is used to designate the uniformity of belief by which a number of persons are united in one denomination or church, as the Roman Catholic, Anglican, or Lutheran communion. *Communio* is employed repeatedly in this sense in the canons of the Council of Elvira (Illiberitanum) A.D. 313. For the examination and comparison of scriptural passages, containing the words *κοινωνία* and *κοινωνεῖν*, the Greek Concordances of the New Testament may be consulted.

Communion is used more especially for the common or public act of sharing or participating in the sacrament, eucharist, or Lord's Supper. Of the origin and use of the word communion in this sense an account is given by Casaubon, 'Exercitat.' 16, § 30. During the first three centuries the communion was celebrated every Sunday. (Bingham's 'Origines Ecclesiasticæ,' vol. v. c. 9.) It was subsequently administered only three times in the year, namely, at Easter, Whitsuntide, and Christmas. By the general council of Lateran, in 1215, it was decreed, in order to check the apparent inclination in many to neglect it entirely, that every one should at least communicate at Easter, that is, once a year. This injunction was afterwards renewed by the council of Trent. For an ample account of the ancient communion service, 'Missa Fidelium,' as well as of the ante-communion service 'Missa Catechumenorum,' we refer to Bingham, vol. v. cc. 1 to 9. There was one form for the clergy, a second for the laity (vol. vi. cc. 2 and 3), and a third and lowest form for strangers or foreigners. Degradation of the clergy to the lay form of communicating in one kind, that is, with bread and no wine, appears to have been an ancient mode of canonical punishment. ('Apost. Can.' c. 14.) The bread appears never to have been omitted: the difference between communicating under one or two species or kinds, as it is termed, being solely in the omission or inclusion of the wine. The communion in two kinds seems to have continued in the Latin church until the end of the 11th century; for in 1099 Pope Paschal II. decreed that little children only should omit the wine, and that the wine alone should be given to those who, from extreme illness, could not swallow the bread. After this period the custom began to prevail of taking the wine by sopping it into the bread instead of drinking it out of the chalice. A letter by Ernulphus, bishop of Rochester, who died in 1124, commends this expedient for several reasons, one of the quaintest of which is, to avoid the profanation of wasting the consecrated wine by the dipping of bushy beards into the chalice. The communion under one species, that is, with bread alone, was authorised in 1415 by a decree of the council of Constance, and was confirmed by the council of Trent in 1562: but, with the exception of the Latin church, all the various sects of Christians have retained the communion under two species. During the first seven centuries the mixing of water with the wine was very generally considered as indispensable to the proper and efficient performance of the eucharistic rite. Justin Martyr, in his 'Apology,' written probably about the end of the 1st or beginning of the 2nd century, observes that the mode of communicating was with a chalice of wine and *water*. It is unnecessary to quote passages from the subsequent fathers in confirmation of this fact. They all appear to have believed the water to be an essential ingredient; and several (Cyprian, 'Epist.' 63, and Athanas. 'in Psal.' 74) assign as the reason of it, that the pure wine of the mystic chalice represents the unmixed nature of God; the pure water represents the nature of faithful Christians; and the commixture of the wine and water represents the union of God and the faithful. A decree of the Œcumenic council, A.D. 691, denounces the Armenians as heretics for celebrating the communion with wine unmixed with water; and the 32nd canon of the council of Trullo decrees the deposition of every bishop or priest who shall omit the water. From the writings of Germain, patriarch of Constantinople; of Cabasilas; of Simeon of Thessalonica; of Balsamon, patriarch of Antioch; of Goar, in his Euchologia; and from the Greek Ritual, it appears to have been a long-established custom in the Greek church to dilute the eucharistic wine with *hot* water, and to administer the mixture hot. To these remarks on the matter of the eucharist, we may add that Epiphanius ('Hæres.' c. 49) and Augustin ('Hæres.' c. 28) speak of an ancient sect of Christians in Phrygia, followers of Montanus, who were called Artotyrites (*ἄρτος, τυρὸς*), because in the communion, they used not bread and wine, but bread and cheese. (Pluquet. 'Dict. des Hérésies.') Others, the followers of Tatian, in the second century, made use of bread and water without wine, and hence were called Aquarians, and Hydroparastai. (Epiphan. 'de Hæres.' 47; Augustin 'de Hæres.' c. 25; Cyprian, 'Epist.' 63.) This sect is also spoken of by Clemens Alexandrinus, and Chrysostom, and in the 5th century it was revived, with a declaration of motives of sobriety. There appears to have been a custom of communicating with consecrated bread and milk, for it is condemned by the council of Braga, in Spain, A.D. 675. The prevalent report in the first centuries, that the Christians celebrated the communion with flour which was kneaded in or with bread which was dipped in the blood of infants, slain or punctured for this purpose, appears to be applicable only to the Christian sects included under the denomination of Gnostics and Montanists; at least several of the Catholic fathers, in repelling the accusation from the orthodox, distinctly fix it upon these heretical sects. (Epiphan. 'Hæres.' 26 and 48; Philastrius, 'Hæres. Bib. Patr.' tom. 4, p. 13; Cyril, 'Catech.' 16, p. 178; Augustin, 'Hæres.' c. 26; Tertull. l. 2, 'ad Uxor.' c. 5; Baronius, 'Annales,' 120-129.) Until the 7th century the communion bread was that commonly used for food; a particular kind began then to be prepared exclusively for the purpose, of a circular form, and impressed with the sign of the cross. The Greek church adopts a leavened bread, but the Roman church has it unleavened; and this difference has been the cause of much controversy, though it seems easy to decide which kind was used by Jesus, the last supper having been on one of the "days of unleavened bread," when no other kind could be eaten in the land of Judæa. It has been a subject of still greater contention whether the proper posture of communicants is that of sitting, reclining, kneeling, or standing. In the 3rd century standing appears to have been the usual posture. See Euseb. 'Hist.' l. vii. c. 9; Tertull. 'De Orat.' c. ult.; Chrysost. tom. i. 'Hom.' 22, p. 260, *παραστῆναι τῇ ἱερᾷ τραπέζῃ*. It is also a subject of dispute whether the ancient Agapæ (*αἱ ἀγάπαι*), which some modern sects continue under the name of love-feasts, were identical with the celebration of the eucharist. Probably these friendly repasts, so zealously continued throughout the four first centuries, were commenced or terminated by the act of communion; for they often took place in the churches until A.D. 360, when they were excluded from the churches by the council of Laodicea, on account of their having become scenes of indecorous conviviality. Tertullian, in his 'Apol.' c. 39, minutely describes the proceedings of one which was conducted with propriety. The fathers frequently speak of the consecrated elements being carried home by the communicants, who gave them to the sick, or kept them deposited in their coffers as a charm against evil spirits, or bore them as a viaticum about their persons in travelling, and in voyages by sea. (Cyprian, 'de Caps.' p. 176; Basil. 'Epis.' 289; Ambrose, 'de Obit. Satyri,' t. iv. p. 315; Cyprian, 'de Spectac.' p. 292; Justin. Mart. 'Apol. 1; Baronius, 'Annales,' 57, n. 151.) Among the many purposes to which the sacramental symbols have been applied, we may notice an instance related by St. Augustin ('Contr. Julian.' l. iii. c. 164) of a child born blind who was perfectly enabled to see, after his mother had put upon his eyes a poultice made of the eucharistic bread and wine. In the first centuries it was customary to bury the eucharist with the dead; and though, by the council of Carthage, A.D. 419, and the Œcumenic council in 691, the custom was condemned, it still continued to prevail; and St. Cuthbert and many others were entombed with the consecrated bread on their breasts, as a safeguard against the molestation of demons. To heighten the intensity of a solemn asseveration, a few drops of "the vivifying blood" were sometimes put into the ink with which the signature was written. Thus, in the eighth council of Constantinople, all the bishops signed the deposition of Photius with a pen "dipped in the blood of the Saviour." Thus Pope Theodore signed depositions; and thus Charles the Bold signed treaties of peace. (Baronius, 'Annales,' 648.) It appears to have been always required that, after the serving of all the communicants, any portion of the consecrated elements which might be left should be immediately eaten by the officiating priests; and by the council of Toledo, in 693, the consecration of a prudent and moderate quantity is enjoined, in order to prevent repletion from eating all that remained. Hesychius (in 'Levitic.' l. 2, c. 8) says, that, in the church of Jerusalem these remnants were burned; and Evagrius ('Hist.' l. iv. c. 35) informs us that, in the churches of Constantinople, the priests sent for a school of children to eat up any large quantity of fragments. To the work entitled 'An Inquiry concerning Infant Communion in the first Ages of Christianity,' we must refer for information on that point of the subject (vol. ii. p. 75); and also to the 'Essays on the Eucharist,' by Pierce and Waterland. In the 5th century the communion was sometimes administered by women, and they continued to officiate at the altar in Italy and France until after the 10th century. (Pope Gelasius, 'Epis. 9 to Bishops of Lucania;' 'Epis. Ratherius, Bishop of Verona.') In the 2nd century the eucharist began to be celebrated in the churches with closed doors, with the exclusion of all but the initiated, on which the Pagan philosophers accused the Christians of having adopted the Eleusinian mysteries of Ceres and Bacthus, bread and wine. (Augustin. 'Contr. Faustum,' l. xx. c. 13.) "The fathers," says the Rev. Mr. Abthorp ('Letters on Christianity,' p. 365), "adopted the language of the Eleusinian mysteries, and most incautiously applied it to the Christian worship; especially to baptism and the eucharist." Many learned writers have noticed some remarkable points of resemblance in the Eleusinian mysteries and the Eucharistic rites, such as their being commemorative, and designed to effect a moral regeneration (*παλιγγενεσία*), or new birth. See Abthorp *ubi supra;* and Casaubon 'in Baronii Ann. exercit.' xvi. p. 478. On the different sorts of communion, see Albaspinæus; Du Pin; Anton. Dominicus; and the very elaborate 'Histoire de l'Eucharistie,' by Arroque.

---

* In the universities, the vice-chancellor, as returning officer, receives and returns the sheriff's precept of election.

COMPANIES, JOINT-STOCK. [JOINT-STOCK COMPANIES.]

COMPANIES, or GUILDS. It is necessary to recollect the nature of the relation subsisting between the English boroughs and the Norman kings in the period during which they successively purchased their civil redemption, in order to be convinced that the local comfort and welfare of the burgesses were objects of little solicitude to those monarchs—that their primary aim was the securing of the regular, punctual, and willing payment of the stipulated rent, and the ensuring in each locality of so much internal peace and order, at least as to them might seem requisite for enabling the community to perform this stipulation with exactness. Further than this they concerned themselves not at all about the internal regulations of the municipality. Its whole community, now rising again from one and the same level of civil nullity, were at liberty to adopt either the ancient customs and usages of the place as existing before the Conquest, or such others as they might think proper to establish in accordance with the common law of the land. The charters were constantly addressed to "the citizens," "the burgesses," or "the men" of such a city or borough; and the sum of the description of a burgess, townsman, or member of the community of the borough, as Madox, in his 'Firma Burgi,' observes, was this: "They were deemed townsmen who had a settled dwelling in the town, who merchandised there, who were of the hans or guild, who were in lot and scot with the townsmen, and who used and enjoyed the liberties and free customs of the town." The municipal body, in short, consisted of the resident and trading inhabitants, sharing in the payment of the local taxes and the performance of the local duties. This formed substantially a household franchise. Strangers residing temporarily in the town for purposes of trade had no voice in the affairs of the borough nor any liability to its burdens, which, at common law, could not be imposed upon them without admission to the local franchise. The titles to borough freedom by birth, apprenticeship, and marriage, all known to be of very remote antiquity, seem to have been only so many modes of ascertaining the general condition of established residence. The title by purchase was a necessary condition for the admission of an individual previously unconnected with that particular community, in those days when such admission conferred peculiar advantages of trading; and the right of bestowing the freedom on any individual by free gift, for any reason to them sufficient, was one necessarily inherent in the community, for the exercise of which they were not responsible to any authority whatever. The freemen's right of exclusive trading too had some ground of justice when they who enjoyed it exclusively supported the local burdens. Edward III.'s laws of the staple authorised the residence of non-freemen in the staple towns, but at the same time empowered the community of the borough to compel them to contribute to the public burdens; and under these regulations it is that the residence of non-freemen appears first to have become frequent.

The progress of wealth, population, and the useful arts, produced, in many of the greater towns, the subdivision of the general community into *guilds* of particular trades, called, in many instances since the Norman era, *companies*, which thus became avenues for admission to the general franchise of the municipality. In their greatest prosperity these fraternities, more especially in the metropolis, became important bodies, in which the whole community was enrolled; each had its distinct common-hall, made bye-laws for the regulation of its particular trade, and had its common property; while the rights of the individuals composing them, as members of the great general community, remained the same.

Nearly thirty years after the express recognition by charter, of the 15 Edward III., of the power in the citizens of London to make bye-laws, it was, by consent of all the commons of the city ordained that each of the *mysteries*, that is, each of the trading companies, should choose certain persons to assent to and ordain, with the lord mayor and aldermen, whatever they should deem advisable; to elect the mayor and sheriffs; and to give counsel in all cases where it was formerly sought of the commons. This was in the 43 or 44 Edw. III., and was confirmed in the 50th of the same reign: but the common-hall or court of hustings of the whole community still retained the right of re-modelling the municipal legislature; and in the 7 Richard II., the common-council was placed on its present footing by an act of common-hall, passed in the presence of the "immense community," to the effect that, as in such large assemblies things had been done more by clamour than by reason, the aldermen, when, on St. Gregory's day in each year, they were appointed for the year ensuing, should be firmly charged, fifteen days after the said day, to assemble their respective wards, and, by good deliberation, charge them to choose four of the most sufficient persons in their ward, to be of the common-council for the year ensuing, &c., provided that of the whole number no more than eight should be of one *mystery*. Except as to the prescribed numbers, which were not strictly adhered to, this act of common-hall took full effect; the whole administrative powers of the community were transferred to the legislative body, composed of mayor, aldermen, and common-councilmen, all subject to annual election; and the ancient hustings-court fell into comparative desuetude; although, on one subsequent occasion, in the 23 Henry VII., we find the mayor, aldermen, common-council, and commons, acting together as one great common-hall, in accordance with the original constitution.

Such was the natural origin of the courts of aldermen and common-council in the city of London; and how closely analogous was their rise in other communities, is abundantly testified by existing documents.

In those instances where the whole of the citizens or burgesses were numbered in the several trading companies, these, for convenience' sake, sometimes formed the basis of the internal polity of the community, and the election of borough officers and members of the common council became vested in them. London itself presents at this day a remarkable instance of incomplete progression from the household franchise to the adoption of that of the guilds; the inhabitant freemen elect the aldermen and common-councilmen; while the *liverymen*, or members of the several companies (so denominated from the distinguishing peculiarities of costume adopted by each fraternity), resident or non-resident, elect the mayor, sheriffs, chamberlain, and other officers. But, in many boroughs, this basis of the guilds wholly superseded the original scot-and-lot franchise, and in the changes of society which have gradually reduced the guilds from their original position, that thorough substitution has been one constantly growing cause of unfair exclusion. The richest and most influential persons, too, being generally chosen by the inhabitants at large to the highest places in the municipal councils, were often tempted to seek the perpetuation of their authority without the necessity of frequent appeals to the popular voice, and even to usurp powers which it had not delegated at all. Such usurpations however were often vigorously resisted by the community at large; and the contests were sometimes so violent and obstinate as to lead to bloodshed. But in course of time, the Crown itself, so long indifferent to the details of municipal arrangements, found sufficient motives for encouraging these endeavours of internal parties to form close ruling bodies, irresponsible to the general community.

In many towns, as still in London, it was necessary, in order to complete his title, that the party should be first admitted a member of certain guilds or trading companies of ancient institution within the borough, and still preserving various degrees of connection with, and subordination to the municipal corporation; a practice which seems to have been formerly still more prevalent. The derivative title conferring a right of admission to these guilds was usually of the same kind as that by which the municipal corporation itself was entered. These guilds were also accustomed to admit by purchase; but such purchasers neither acquired nor could convey any absolute right to admission into the municipal corporation. Occasionally, an incorporated guild has continued to exist after its connection with the municipal corporation has been almost or wholly dissolved.

The titles from birth, marriage, and apprenticeship, were very various in different places. In some, the right by birth was enjoyed only by the children of freemen born within the borough; in others, by children of freemen wherever born; in some, the father's admission at any time conferred the inchoate right on all his children wherever born; in others, only on those born after, and in many, only on the first son born after his admission. Less variety is found in the nature of the title which a freeman's daughter or widow must possess, to enable her to convey the privilege. The right by apprenticeship has usually accrued by service under indentures for seven years to a freeman within the borough: service at sea has generally been considered in the light of service within the borough where the vessel belonged to its port: in some boroughs having trading companies, the binding and service must be to one of the company in the trade peculiar to that company.

COMPANY, in military affairs, is the body of men which constitutes one of the principal divisions of a battalion of infantry, and which corresponds to the troop in a regiment of cavalry. The strength of a company in the regiment of artillery is 120 men, in the guards and line 80 men. In each battalion there is one which is called the grenadier company, and another the light company; and these are called flank companies from their stations, which, when the battalion is drawn up in line, are at its extremities. The grenadiers acquired that denomination from the grenades, or small shells, which they were trained to throw by hand into an enemy's works; and the light companies were so called from their being required to act as the skirmishers of the battalion. Every company of the line and militia is commanded by a captain, under whom are a lieutenant and an ensign, besides the non-commissioned officers; formerly in the regiment of Artillery, the Rifle Brigade, the corps of Royal Engineers and Marines, and the Fusilier regiments, each company had, instead of an ensign, a second lieutenant. The rank of second lieutenant has now, however, been done away with, being changed to that of ensign in the case of the Rifle Brigade and Fusilier Regiments; and to that of lieutenant in the Royal Artillery, Royal Engineers, and Marines. The rank, however, does not carry the pay of lieutenant with it to any besides the established number; those who would under the former regulations have received the pay of second lieutenant, still only receive it.

In France, the first formation of bodies of men under the denomination of companies, may be said to have taken place in 1373. [CAVALRY.] But the institution in that country of what approaches nearer to the present signification of the word, occurred in 1557, when Henry II. divided a French legion into fifteen bodies of 400 men; each of which, except the two first divisions or companies, was commanded by a captain, a lieutenant, and an ensign, besides two serjeants and eight corporals. Those two companies were considered as being immediately under the command of the colonel himself, and therefore had no officer of higher rank than lieutenant. This regulation seems to have been followed in the British service, since formerly in each regiment there were two, called the colonel's companies, which were commanded by lieutenants only, who, however, were by courtesy entitled captains.

It is observed by Grose, that probably from the time of the Conquest the English infantry was divided into corps, consisting of 1000 men, which were subdivided into hundreds and tens. And he remarks that in the list of the army engaged at the siege and battle of St. Quentin, in 1557, each company is stated to consist of 100 men, and to be commanded by a captain, a lieutenant, and an ensign, as at present, besides a serjeant, a harbinger or quartermaster, and a drummer.

COMPASS, HISTORY OF THE. The knowledge of the directive power of the magnet was unknown to the Greeks, the Romans, and to European nations generally till late in the 12th century; and does not appear even then to have been brought into common use for nautical purposes. It has however been so known and so used in China, Japan, India, and Arabia from periods of high antiquity. Doubts, indeed, have been often expressed of the validity of the claims of the Chinese, and of the authenticity of the dates attributed to the notices of it in the grand annals of their empire; but the most careful examination of the Chinese claims does not warrant our scepticism on one point or the other. The Jesuit missionaries who went to China in the beginning of the 17th century, were of course little likely to admit the high antiquity claimed by these annals without rigorous inquiry; nor, without evidence of great force, to give up in any degree, even implicitly, the chronological authority of the Vulgate Scriptures: yet this was not only the case, but upon their return they unanimously agreed in the conviction that those records were authentic, and several of them published that conviction to the world, at no small degree of risk to their reputation for orthodoxy. No exact translation into any European language of the passages from which they drew their accounts of the directive properties of the magnet, had, however, been given till the year when Klaproth published his 'Lettre à M. H. Humboldt sur l'Invention de la Boussole,' at Paris; and a translation of the passage in question has been again given in English by Mr. Davies in his 'Early History of the Mariner's Compass,' published in the 'British Annual for 1837.' The circumstance, from its incidental mention, seems to give greater authority to the passage. It relates to the date 2634 years before our era.

"Houang-ti punishes Tchi-yeou at Tchou-lou.

"The Waï-ki said: Tchi-yeou bore the name of Khiang; he was related to the Emperor Yan-ti. He delighted in war and turmoil. He made swords, lances, and large cross-bows to oppress and devastate the empire. He called and brought together the chiefs of provinces: his grasping disposition and avarice exceeded all bounds. Yan-ti-yuwang, unable any longer to keep him in check, ordered him to withdraw himself to Chao-hao, in order that he might thus detain him in the west. Tchi-yeou nevertheless persisted more and more in his perverse conduct. He crossed the river Yang-choui, ascended the Kieou-nao, and gave battle to the Emperor Yan-ti at Khoung-sang. Yan-ti was obliged to retire and seek an asylum in the plain of Tchou-lou. Hiuan-yuan (the proper name of the Emperor Houang-ti) then collected the forces of the vassals of the empire, and attacked Tchi-yeou in the plains of Tchou-lou. The latter raised a thick fog, in order that by means of the darkness he might spread confusion in the enemy's army. But Hiuan-yuan constructed a *chariot for indicating the south, in order to distinguish the four cardinal points;* by means of which he pursued Tchi-yeou and took him prisoner. He caused him to be ignominiously put to death at Tchoung-ki. The spot received, from this circumstance, the name of the plain of the broken curb."

Other Chinese accounts vary as to language and as to circumstances relating to the personal character of Tchi-yeou; but they all agree in the statement respecting the *Tchi-nan* (or chariot of the south) being constructed by the emperor on that occasion; and it is remarkable that the very name by which the instrument is denoted, like every thing else Chinese, is retained almost unvaried from the earliest period of their history down to the present times.

Though numerous other passages of various dates speak with equal explicitness of the use of the compass for land purposes, yet no mention of the use of the magnet for *navigation* occurs in any of their books that have come to the knowledge of Europeans, till the dynasty of Tsin, which lasted from the year A.D. 265 to 419. It is in the great dictionary Poi-wen-yeu-fou; and it is there stated that "there were then ships directed to the south by the needle." Mr. Davies contends that this passage rather refers to the magnitude of their ships and the extent of the voyages which they performed, than to the introduction of the needle into marine affairs. In the 9th century two Mohammedan travellers travelled into Arabia, an account of whose journey was published from an Arabic manuscript (which bears internal marks of being written as early as the close of the 11th century) by Eusebius Renaudot, at Paris, in 1718. In this it is stated, that the Chinese at that period (the 9th century) traded in ships to the Persian Gulf and the Red Sea; and though the compass is not mentioned, it is utterly improbable that the Chinese should have known the directive property of the magnet, and have *used* it on land for thirty centuries, and yet not have employed it at sea. It was known on the Syrian coast before it had come into general use in Europe, as is obvious from the following passage from a manuscript witten in 1242, by Baïlak Kibdjaki, which is very explicit in its description of the nautical compass: "We have to notice, amongst other properties of the magnet, that the captains who navigate the Syrian Sea, when the night is so dark as to conceal from view the stars which might direct their course according to the position of the four cardinal points, take a basin full of water, which they shelter from wind by placing it in the interior of the vessel; they then drive a needle into a wooden peg or a corn-stalk, so as to form the shape of a cross, and throw it into the basin of water prepared for the purpose, on the surface of which it floats. They afterwards take a loadstone of sufficient size to fill the palm of the hand, or even smaller; bring it to the surface of the water, give to their hands a rotatory motion towards the right, so that the needle turns on the water's surface; they then suddenly and quickly withdraw their hands, when the two points of the needle face north and south. They have given me ocular demonstration of this process during our sea-voyage from Syria to Alexandria in the year 640" (of the Hegira). An older passage than this might have been quoted, did the limits of our article allow of amplification; but this has been chosen on account of the distinctness of the description. When we consider the jealousy with which all knowledge was guarded by its possessors, especially that of *commercial* value, we cannot but admit that the use of the compass must have been very common at a period when a passenger was initiated into the complete knowledge of the mode of magnetising the steel needle, as well as the mode of using it.

In 1260, when Marco Polo returned from his travels in Cathaï, he is believed to have brought a knowledge of the compass, as well as other Chinese inventions, back to Europe with him; but there is no known authority for this opinion that can lay claim to authenticity. It is certain, however, that before the close of the 15th century, when Vasco de Gama found his way round the Cape of Good Hope, the pilots of the Indian Seas were expert in the use of sea-charts, the astrolabe, and the compass.

A passage extracted from the 'Landnamabok' of Are Frode, who lived about the close of the 11th century, has been brought forward by Professor Hansteen to prove the use of the magnetic needle for purposes of navigation at least as early as that date, in Norway; "*for in those times seamen had no loadstone in the northern countries.*" But this passage is most probably an interpolation by the continuator of the chronicle, which view is supported both by the remark of the editor, Finæus, of the chronicle itself, as well as by the circumstance of the whole passage not being found in three different manuscripts. Its authentic origin cannot reach higher than the 14th century. ('Brit. Ann.,' p. 296.)

The mariner's compass is, however, minutely described by Guyot de Provins, who wrote his satire entitled 'La Bible,' about the year 1190. This has usually been assumed to contain no indication that the mariner's compass was a recent discovery or only little known in France at the time of the composition of the satire; but Mr. Davies considers that the minuteness of the description itself, as well as other collateral evidence, proves clearly that it was an instrument at that time not only not much known, but a total novelty. Guyot, a minstrel by profession, had probably seen it in use during the Crusades, to one of which most likely he had previously attached himself. At all events, Cardinal de Vitry and Vincent de Beauvais, both Frenchmen, and both Crusaders, writing at a later period by a quarter or half a century than Guyot, speak of it as a great curiosity which they saw in the East, and as a thing perfectly new in Europe would be spoken of. There is not hence the slightest foundation for the belief that it was used by European seamen at so early a period, though there can be but little doubt that by the middle of the 13th century it had come into partial use and into general knowledge; since, in one of the songs of Gauthier d'Epinois is an *allusion*, which no one would have made had not his auditors been familiar with the magnetic needle.

It was long contended, that the inventor of the compass, as a *nautical* instrument, was Flavio Gioja, a native of Amalfi, near Naples, and the date given by the Italians is from 1300 to 1320. It will be obvious, from what we have already said, that there is no foundation for this opinion; and independently of this, the authority of the statements themselves is invalidated by an appeal to the facts which are affirmed in proof of it, as may be seen either in Klaproth's letter or in the 'British Annual.' Before this assigned period, even the 'Trésor' of Brunetto Latini (the master of the Divine Dante) bears evidence that the compass was not a rarity. It is, however, highly probable that Gioja greatly improved the compass, either by its mode of suspension, or by the attachment of the card to the needle itself, or in some other important particular.

The French have laid claim to the discovery of the compass, or at least to the attachment of the card to the needle, from the circumstance of the north point being marked with the *fleur-de-lis;* but in the absence of all distinct evidence on this point, it is much more probable that the view taken by Mr. Davies is correct,—that the figure is an *ornamented cross*, and originated in devotion to the mere symbol; though, as he observes, as the compass undoubtedly came into Europe from the Arabs, the *fleur-de-lis* might possibly be a modification of the *mouasala* or dart, the name by which the Arabs called the needle.

The discovery of the variation of the needle was generally (before the appearance of Cavallo's 'Treatise on Magnetism') attributed to Columbus, but since that time it has been assumed as being very early known. [DECLINATION OF THE NEEDLE.]

The dip of the needle, or its *inclination*, was the undoubted discovery of an Englishman, Robert Norman, a nautical instrument maker at Wapping, who published an interesting account of the course of his experiments in 1594, under the title of the 'New Attractive.' [DIPPING NEEDLE; MAGNETIC INTENSITY.]

The *variation of declination* is also an English discovery, having been made, as is well authenticated, by Stephen Burrowes, of Limehouse, and fully determined by Gillebrand, professor of geometry in Gresham College; and the diurnal variation of the declination also unquestionably belongs to another Englishman, Mr. Graham, about 1719.

England, in the person of an intrepid and accomplished navigator and marine surveyor, Capt. Flinders, claims another discovery of great and enduring importance. In his memorable but unfortunate voyage in the "Investigator," he first detected the cause of errors in the variation of the magnetic needle as depending on the direction in azimuth of the ship's head. The value of this has been extensively felt among nautical men, and considering that the announcement of his discovery was made ('Philosophical Transactions' for 1805) during the six years he was unjustly imprisoned and detained at the Mauritius by the French governor, De Caen, and that on his release, with greatly impaired health and pecuniary resources, the numerous experiments made under his directions at Sheerness, Plymouth, and Portsmouth, fully confirmed his original views, the name of Flinders will stand forth prominently in nautical history as one of the most persevering (though unrequited), as he was one of the most accurate, among modern surveyors, and scarcely second to Cook among modern navigators.

COMPASS, AZIMUTH, is a compass with plain sights, and with vertical wires attached to it in such a manner as to be moveable round a vertical axis independently of the compass-card. A pointer shows angle which the position of the telescope, or sights, marks out on the card, that is, the bearing of the object towards which the sights are directed. This angle is the azimuth of the object, when the correction for magnetic variation is made. But when the bearings of two objects are measured, the correction need not be applied in merely determining the difference of bearings, since the error affects both equally.

When observations in azimuth requiring greater accuracy are taken, an instrument called a Theodolite is used. [AZIMUTH; THEODOLITE; CIRCLE.]

COMPASS, THE MARINER'S. A magnetic needle balanced on a pivot will, subject to corrections for the variation of the magnet on account of terrestrial influence, point out the true direction of north and south. A card bearing the points of the compass, and unalterably attached to any apparatus, such as a globe, will therefore afford the means of adjusting it north and south, if the centre of the card be made the pivot of a magnetic needle. In the mariner's compass, however, it is usual to affix the needle to the card, pointing towards its north and south point, so that the card travels with the needle; and if a pointer (fixed with respect to the ship) mark out the point on the edge of the card which lies in the line drawn through the pivot parallel to the plane which symmetrically bisects the ship, the bearing of the ship's head is shown by the part of the card to which the pointer directs for the time being. Instead, however, of a pointer being used on board ship, it is usual for a mark to be drawn upon the inner surface of the compass-bowl, a line between which and the centre of the compass being always parallel to the ship's keel. To ensure the horizontality of the compass-card, the cylindrical box or bowl in which it is enclosed, is supported in a hoop at opposite points, by pins projecting from it, so as to allow the box to revolve inside the hoop. This hoop is supported in the same manner on pivots, the line of which is at right angles to the first pivots; so that between the rotation of the compass-box in the hoop, and the hoop itself, the former can always find its position of equilibrium, which is the horizontal position. The small oscillations of the apparatus are immediately destroyed by the friction. The apparatus is then said to be supported on gimbles, or gimbals.

By whom the suspension now generally used was invented, is altogether unknown from any document or other evidence. The suspension of the whole machine itself on two circles, whose suspending diameters are at right angles to each other, is, however, on all hands admitted to have been English, though we are still ignorant both of the person who invented it or the period of the invention. It appears to be traditional evidence on which the opinion rests; but a tradition in which rival nations agree, bearing on an invention which would be honourable to any one to have a power to claim, can hardly be supposed an erroneous one. Voltaire, in his essay on 'Universal History,' seems to confirm the English claim, when he admits that "the first who certainly made use of the compass were the English, in the reign of Edward III." He speaks of a Carmelite friar of Oxford named Linna, an able astronomer of those days, having sailed as far as Iceland, when he drew charts of the North Seas, which were afterwards made use of, in the reign of Henry VI. But Voltaire should have applied his assertion to an improved form of it, rather than to the circumstance of its use for the first time. Still, even in England, in the time of Queen Elizabeth, the construction was very rude in its execution.

The mechanism of the compass is a subject affecting so largely the commercial interests of Great Britain, that not only does the safe transit of the goods of the merchant depend on its proper adaptation to the principles on which magnetism can be available to the sailor, but much of the safety of ships of war, in particular, will be involved in the accuracy of working shown by these instruments. Our unnautical readers will easily understand the importance of a correct manufacture of the compass when the following case is assumed in illustration: Let two ships of war, of equal size, shape, and fittings, and commanded respectively by pilots of equal skill, attempt, in hazy weather, to enter the Thames or some other estuary difficult of approach. Let their compasses be from the same maker and alike, and of ordinary construction, as now used in H.M. navy. It is quite possible that one ship may reach her port in safety, while the other may suffer total wreck; for the secret of the safety or loss of the ships may even have depended on the following simple circumstance: In the one case, the wary old quarter-master at the "con binnacle" shall have attached a piece of packthread to the compass-rim, by lightly jerking which occasionally the compass-card will have been kept more "alive" on its needle point, or have moved more freely on its pin; while the quarter-master in the other ship may have thought such precaution uncalled for, and the sluggishness of the compass have caused an erroneous impression as to her courses. Some remarks, therefore, as to form and manufacture are called for, having for their object the development of a compass system calculated to avert not only existing inconveniences, but those calamities which the introduction of iron into shipbuilding in the merchant service, and the increased armament with heavy ordnance (and especially the adoption of Armstrong's steel gun) into her Majesty's service afloat, would, if unheeded, entail upon the navies of the maritime kingdoms of the world.

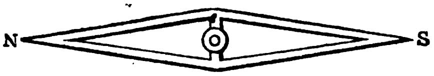
So much has been written and said upon the compass of late years, so many of our ablest philosophers have devoted their attention to the improvement of the mariner's compass, that, seeing the results of their labours in the complexity and variety of form which have still further complicated the question in the eyes of the unscientific, it will be well to review slightly the past, taking, however, the present condition of the compass as the best and most profitable subject for our consideration. A slight glance at the history of the compass will assist us in our conclusions, inasmuch as the experience of centuries will have its bearing upon and considerably influence them.

The most simple and primitive form of the compass appears to have been either the magnetised needle thrust transversely through a cornstalk, and left floating in a screened basin of water [COMPASS, HISTORY OF THE], as used on the Syrian shore; or the small Chinese needle, resting, just below its centre of gravity, upon a needle-point fixed on a wooden stand. The greatest amount of steadiness on the one part, and activity of the needle on the other, seem to have been obtained, so far as regards mere form. (We, for the present, leave intensity out of the question.) But it must be remembered, that steadiness might amount to sluggishness, and activity might merge into inconvenient oscillation. A modified form, therefore,—one combining both qualifications,—has, through many centuries, been the navigator's *desideratum*. It is curious to notice how varied have been the attempts to produce a good and unobjectionable compass. Still more are we astonished and humbled to see in the most recent (so-called) "improvement" the very principle of the floating compasses, as described in 1242 by Baïlak Kibdjaki!

Scarcely any modification of form had occurred, certainly for the three centuries previous to the time of Richard Norman of Limehouse, in 1590. Norman appears to have introduced some change, in what, however, one would imagine his only *improvement* to have been, the adding of a counterpoise to the ancient Chinese form of needle, rendering it, by means of a weight sliding on the needle or bar, susceptible of adjustment in removing it from one part of the earth's surface to another. [DIP.] Probably few successful attempts had, till very recently, been made to examine the magnetic conditions and changes to which the needle was subject, or the advantages of one form of the needle itself over another. The only improvements seem to have been those which insured greater nicety of construction. Our countryman Michell subsequently increased the efficacy of the needle by his invention of what was called the double touch, which symmetrically diffused the magnetic influence in the two arms of the needle; and early in the present century, Captain Kater directed his attention to the imparting of the greatest amount of directive intensity by experimenting largely on the form and temper of the metal of the bar. Several men of science, and among them Professors Barlow, Lloyd, Arago, Faraday, Wheatstone, Airy, &c., and also Messrs. Biot, Haüy, Coulombe, Dr. Gowan Knight, Dr. Scoresby, Sir Wm. Snow Harris, and others, from the delicacy, beauty, and success of their experiments, created an interest in the matter never before felt; but these researches were, with some exceptions, rather confined to the properties of the bar or needle than to the precise form of compass to be used on shipboard. It is however proposed to limit our considerations in this article rather to the mechanical form of compass than to abstract principles, which will be referred to in their proper place under the word MAGNETISM.

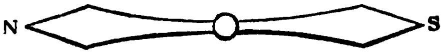
While it is admitted by many (and among them by Sir Wm. Snow Harris) that the sensibility and delicacy of the primitive *small* needle of the Chinese are quite surprising, and while Michell and many others approve of the *very light* steel bars of the Chinese to be used as compass-needles (because magnetic power increases in a less degree than the friction arising from increase of weight), it is singular that those now in use are quite of opposite construction. As many as, or more than, four or five bars being now attached to the same card, and resting on the same needle-point, their weight, as might be expected, increasing friction to such a degree that even agate caps soon *wear out* and become useless. Mr. Stebbing, an eminent optician at Southampton, partially obviates the inconvenience of this by substituting the ruby. Few individuals gave more attention to magnetism and to the accuracy of form in the needle than the late Dr. Scoresby; but it appears that no improvement in shape resulted from his long continued labours. Dr. Gowan Knight, the first appointed principal librarian of the British Museum, a man of persevering research in science, who wrote a century since, described the form of compass-needle used in his day by the merchant service as formed of two steel plates bent at their centres and meeting at their ends, and forming the two poles, in this manner:—

Fig. 1.



But he found that when the temper of the metal in each piece differed, the directive intensity was not in the axial-line of the mass, nor did polarity at all times exist precisely *at the ends* of the needle. At the same period he describes the form of bar as used in H.M. navy to have been as under:—

Fig. 2.



In this he detected a capability of its having no less than six poles, while the greatest available directive force can only exist when there are two. His investigations of the question established the still admitted fact, that the form of needle best adapted to the mariner's compass was the regular parallelopiped, being a straight bar with its narrow dimension placed vertically. Dr. Knight also found that the mode of suspension adopted by the Chinese,—namely, the suspension of the needle at a point a little below its centre of gravity,—was the best, as conducive to sensibility. He moreover recommended the use of such a needle *without central perforation*. Dr. Knight's form of needle was for a long time adopted in H.M. ships; and, as Sir Wm. Snow Harris, with undoubted propriety, in his excellent 'Manual of Rudimentary Magnetism,' suggests, "it is still worthy of serious attention." Perhaps in no one branch of science has more valuable time been bestowed in the construction of an instrument than in the attempt to perfect the needle and mariner's compass. Sir William Snow Harris has, in a form of compass which bears his name, adopted the suggestions of Norman in 1590, as regards the compensating slides on the bar, and also the opinions of Dr. Knight in 1750, with reference to the form of needle; but its chief excellence is in the amount of directive force imparted to it. He also adopts the *light* form of needle, but not to the extent found in a Chinese instrument.

Enough has been said to show that the precise form and arrangement of the mariner's compass has long been a question of public anxiety; and still more must its consideration press upon us when to the new armament of ships and the increased use of iron afloat (as already noticed), must be added the increased amount of iron carried as cargo, and the circumstance of increased speed of ships which brings them more suddenly into danger; these beset navigation with difficulties only to be surmounted by a well-founded confidence in the form, and *simplicity in the mode of using* a well-made compass, and this can only be attained by careful investigations and unfettered and disinterested conclusions.

It is worthy of remark here that to such an extent has the public mind at times become embarrassed with this consideration, that in 1854 a panic on the Liverpool 'Change nearly excluded for several days the iron ships of the port from freight engagements. It arose from the following circumstance: The late Rev. Dr. Scoresby, with that honesty of purpose and plainness of elucidation for which he was remarkable, informed the merchants of Liverpool of various discoveries as to the causes of local disturbance in iron ships, such discoveries having however a tendency to cast doubt and distrust around that on which hitherto the sailor had relied as his faithful conductor through the pathless oceans of the globe. [LOCAL ATTRACTION.] The insidious workings of the magnetic influence, then for the first time made known to the commercial world, and this too under the sanction of a meeting of the British Association, naturally alarmed the ship-owner, appalled the merchant-captain, and lent its aid towards general confusion. Although the discoveries of Dr. Scoresby are of absorbing interest to the philosopher, and have assisted others in their laboratories, yet to the mariner or the ship-owner these subtle workings of the magnetic current ought to have presented very little *real* difficulty, as was promptly shown in a published address by Mr. Saxby to the ship-owners of Liverpool, and also by the judicious and timely appeals to them by Mr. Grantham, a very eminent marine engineer of that town. The effect of this on the compass question was, the almost immediate production of such a variety of forms of the instrument as were calculated, it was supposed, to pacify the ship-owners; but it actually left the ship-captain burdened and bewildered with novelties and perplexities which even now, in a great measure, render the correction and use of the compass, notwithstanding its importance, the least satisfactory, the most anxious, and the most tiresome of all his work at sea. This competition, however painful in its early operation, had, in a national point of view, a salutary effect. It loudly evoked the hidden talent of officers in the mercantile marine. It aroused their energies, and demanded of them something beyond attention to the mere routine in which they had been trained. Ship-captains soon found among their numbers many men of sufficient talent to grapple with the compass question, and that large and respectable body, relying on themselves rather than on men of reputed science, began to judge for themselves as to the merits of the various toys placed into their binnacles by credulous owners; and many an absurd, though presumptuous and specious form of compass has already been by them consigned to oblivion; many ingeniously contrived instruments, good in themselves but totally unfit *for sailors' use*, have gradually sunk or are yet gliding visibly into disrepute. With that promptitude, however, which characterises Liverpool merchants, soon after the announcement made by Dr. Scoresby, a Compass Committee, seconded by the authorities at the Board of Trade, was formed, and a vast collection of facts speedily poured in from those who were interested, and measures were taken to assist navigators, which will be clearly and more properly detailed under the head of LOCAL ATTRACTION in this work. But nothing resulted from their really praiseworthy and indefatigable investigations, calculated to modify the generally existing form of mariner's compass: *nothing new* appears to have been suggested by that body indicative of real improvement in the instrument.

Although we must not in this article enter far into the question of local attraction, yet as its causes have led to some modifications in the form of compasses to facilitate corrections for deviation, &c., it is necessary to notice that the Astronomer Royal, having long turned his powerful mind to the question, announced to the world a theory of local attraction which involves the necessity for soft iron as a part of the compass-correcting arrangement. No greater proof of the difficulties which surround the mariner's compass as a nautical instrument can be adduced than the fact, that, although now some few years have passed since Professor Airy first gave to the world his really simple and elegant theory for correcting by magnets and soft iron, his opinion remains unseconded and *unadopted* by the Admiralty, by whom correcting magnets are rejected altogether, from extreme and irreprehensible, but possibly overstrained, prudence. It is not improbable that a number of the fallacious methods of correction of the compass produced of late, have so deluged the authorities at the Admiralty with suggestions thereupon, as to somewhat blunt the intelligence, and thereby obscure the truth, *even when offered by the Astronomer-Royal himself*. It must also be remembered, and indeed it is a fact well-known to the writer, that many merchant-captains who have had their compasses corrected in port by the use of fixed magnets, have found such error and inconvenience arising therefrom (on account of subsequent changes in the magnetic condition of the ship), that rather than endure the annoying discrepancies and perplexities consequent on their use, they have pitched their correcting magnets overboard altogether; preferring to encounter the magnetic dangers of the voyage with a single well-made compass which they *did* understand, to tampering with changeable and vacillating agents and appliances which were above their comprehension. Such may account for the authorities at the Admiralty rejecting the use of correcting magnets altogether.

Taking even Professor Airy's theory of moveable adjusting magnets and soft iron as an instance, how few merchant-captains, unaided by a mechanically convenient correcting apparatus, could follow a learned discussion on so intricate a science as that of magnetism (however valuable in itself); much less could they use the mathematical formulæ necessary for its application to the mariner's compass. It remains to state that a practised compass-maker, a Mr. John Gray, of Liverpool, an optician of talent well known in all the principal ports of Europe, after study and experiment on an extended scale in which he believed he could corroborate physically the theoretical assumptions of Professor Airy, contrived a compass arrangement which, apart from all invidious selection, and from a sense of public duty, finds an illustration in this article. Several other forms for correction of the compass-needle exist, and each has its advocates, but the following sketches of Gray's compass arrangement give an idea of the form in which the Astronomer-Royal's suggestions are being carried out.

Fig. 1.

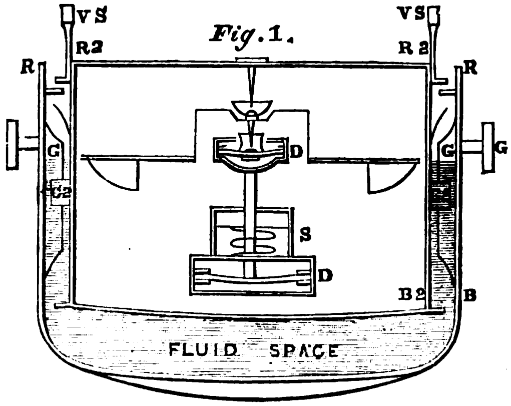
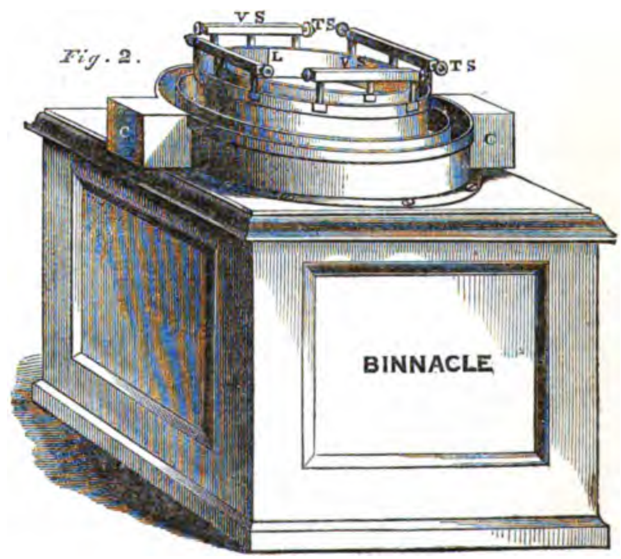


Fig. 2.



B, Outer bowl, containing fluid, in which, B 2, inner bowl is floated; R and R 2, Rims of outer and inner bowls; V S, Springs to keep the bowls in central position with each other; T S, Tangential screws to adjust the bowls to their centres; G and G 2, Guides to prevent rotatory motion; L, Lubber's point; D, Elastic discs; S, Spiral spring; C, Chain boxes for soft iron; G 3, Gimble.

The above has, moreover, an interest from being the form of apparatus used on board Her Majesty's yachts; and without compromising that independence of thought and rigid impartiality which ought to characterise this work, we may remark that it is said by the Astronomer

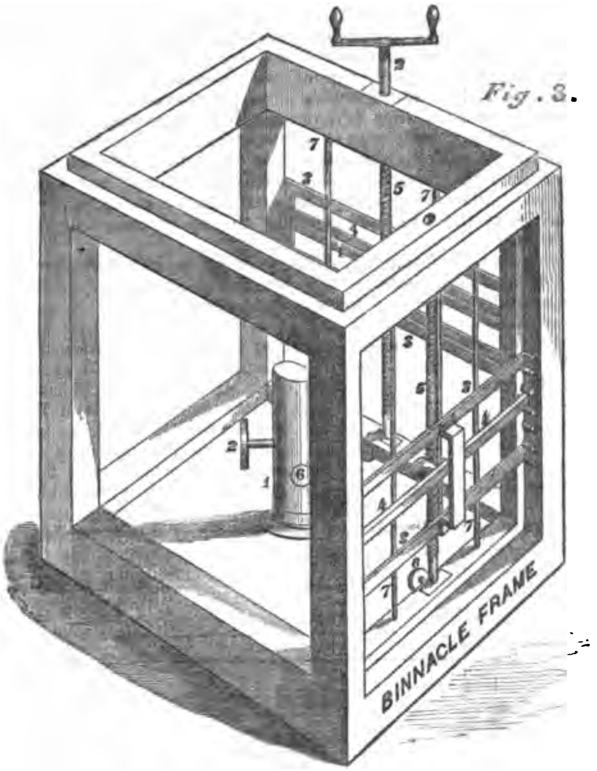


Fig. 3.

1, Cylinder containing vertical magnet; 2, Keys to raise and lower the magnets; 3, Frame in which the magnets are placed; 4, Magnets; 5, Vertical screws for raising and lowering the magnet frame; 6, Screws to prevent the vertical screws altering their position; 7, Guides to the magnet frame.

Royal publicly to be "perfectly correct," as to the principles under which it is constructed, and "entirely satisfactory" to him. The one property which (while there might seem to be some complexity in the mode of suspension) distinguishes this apparatus from others, is the facility with which the adjusting magnet can, under very simple printed instructions from the maker, be altered in position, so as to compensate the changes produced from alteration in the magnetic condition of the ship.

Nothing is intended herein to disparage the beautifully constructed and excellent compasses made by those whose names have been mentioned as some of the principal makers of this country. A very elegant form of compass, in which the magnet is attached to a vertical metallic zone, and the whole inclosed in a glass globe, has been invented recently by a Mr. Gowland, of Liverpool. It is for practical men to satisfy themselves thoroughly if the three grand *desiderata* of the compass be fulfilled in any one instrument; these are:—

1. Steadiness, without sluggishness.
2. Activity and sensibility, without oscillation.
3. Facility for correction under local attraction, without complication.

COMPASS CORRECTION. Under the word BEARING, some notice has been taken of the most recent improvements in the method of using the compass for nautical purposes.

It is ordinarily supposed by landsmen, that with a well-made compass, and a knowledge of the variation thereof, as depending on terrestrial changes [VARIATION], and this to be applied on either hand of any given point, according as the magnetic needle deflects towards the east or west from the true pole of the world, or the meridian, a navigator might find his way to distant parts of the earth; but the need of correction from other causes, daily or hourly in some ships, gave rise to and constitutes what has been so long called and agitated as the compass question.

The navigator's desire at sea is simply to know on *what angle from a meridian*, or true north and south line, *his ship is sailing*. But before he can arrive at a satisfactory conclusion as to his correct course, the various channels through which local attraction affects his compass have to be estimated; in other words, he must free his compass bearing from all casual local magnetic influences; and this constitutes the work of *compass correction*. If such were easily performed, on merely knowing the deviation [DEVIATION], an ordinary additive or subtractive operation would suffice; but it unfortunately happens that the quantity of iron used about a ship, and especially in a steamer, presents a combination of disturbing forces so intricate in their relations, that *no man of experience should rely on any mere system of instrumental correction, independent of actual observation of a heavenly body*, much less will he rely *solely* on a correcting card, or correcting magnets. It may here be well to explain so clearly the present state of things, that the difficulties which have hitherto clouded the brow of the master mariner, plunged him into uncertainties and unnecessary labour, depriving many a weather-beaten and storm-tossed mariner of his nightly rest, may, in those whose intelligence really befits them for their duties, be *totally set aside;* and that ships may henceforth be navigated with a confidence and security profitable alike to their owners, their crews, and the public.

The system of correction at present adopted in Her Majesty's navy is the following: A line-of-battle ship, having on board nearly 500 tons weight of iron guns, shot, and shell, being moreover a screw steamer, with all her massive machinery, an immense iron funnel, iron water tanks, iron anchors, iron cables, &c., is fitting for sea, off one of Her Majesty's dockyards, say for example, Sheerness, either before or after the usual trial trip (generally before), and it is thought necessary to swing her for compass correction. Where no distant and conspicuous object is in sight, this is done by sending a trusty officer on shore at an assumed station, say at the Isle of Grain, with an azimuth compass. The ship is then turned about, so as to bring her head to every point of the compass, and by comparing simultaneous observations (made during the time of swinging) between the ship and the station, and the station and the ship, some notion can be formed of the local attraction on board: thus, if the officer on board at a certain moment sees (for example) his assistant at the station on shore bearing due west by ship's compass, and the assistant on shore at the same time sees the officer on board bearing, not east, the opposite point, but E.S.E., there must be, in one or both instruments, a total deviation of two points, or 22° 30′; but as the compass on shore is carefully placed, so as to be beyond the influence of any local attraction, the deviation is always attributed to some magnetic disturbance on board. These deviations, as found on each point, are carefully noted and collected, and form what is generally called a correcting card. Various methods have been proposed for the registering of these deviations; perhaps nothing more simple and ingenious has been offered than the one by Sir Archibald Smith, in the form issued by the Admiralty to each of Her Majesty's ships. The swinging of a ship, then, is nothing more than a mode of finding the error of her compass at a certain moment; but as there are other methods of ascertaining this so important a fact, it is necessary to consider *which of the many is the most accurate, simple, and convenient* in application and practice.

The swinging of a line-of-battle ship is a work of labour, time, and expense; it often occupies three or four days, the employment of about 800 men, the wear and tear of two, three, or four hawsers, the letting go and weighing two or three heavy kedge anchors;—all this is necessary in swinging a ship of the line. But the advantage of ascertaining precisely the state of such ship is paramount, and we should spare no time, labour, or money, if a permanent result could thus be obtained. It unfortunately happens, however, that any change which may occur in the magnetic condition, or even position of the iron on board, such as the training of a gun, the firing of a broadside, lighting the fires of the engine, moving the ponderous funnel up or down, and various other unavoidable operations on shipboard, may so affect the compass as to render a correcting-card, obtained at *one time* with so much labour, totally useless at *another*. It is true that some ships have been found to undergo very little changes during long periods; but, on the other hand, it is equally well known that steamers which have preserved a remarkably equable state of magnetic condition for years, have suddenly shown disastrous changes. To mention only one case out of hundreds, in support of this assertion—an iron steamer, belonging to one of the principal companies of Liverpool, which had shown great uniformity as to local attraction for several years, was, in 1857, proceeding down Channel, under the command of a distinguished officer, who was on his 73rd voyage past that coast. It was a pleasant, calm, hazy evening, and the commander supposed, from her standard compass, that the ship was heading fairly for the Longship's light. But just after sunset a cry suddenly arose from the look-out man, of "Rocks ahead!" and to his amazement the experienced commander found himself running stem-on to the Stones in St. Ive's Bay. It was afterwards found by the writer of this, that the local attraction on board must have varied 16 degrees after leaving Liverpool. The ship and crew were barely saved from destruction; an instance of the high importance of the subject now under our consideration; for we have *no means of ascertaining the amount of liability in any particular ship to vary her condition, hence the doubtful value of any correcting-cards* whatever. The subtle disturbing element may at any moment, from unforeseen causes, accumulate in this gun, or that range of shot, or in some particular iron knee, or chain, or iron stanchion; so that the wary master or commander may suddenly, and at any time, be deprived of that in his so-called correcting-card, the loss of which would necessarily entail much anxiety, until opportunity presented itself of checking the state of the compass by a celestial observation.

As an important public question is deeply involved in this scrutiny of the practice of swinging a ship, an operation shown to be not only expensive and troublesome, but *absolutely dangerous if too much reliance be placed upon it*, it may reasonably be asked why we permit fallacies to exist in our system. In such a cause, it behoves every man of science who would assist the navigator to cast aside all prejudices and mere "customs," and, taking the simple *facts* of the case, attempt a total revision of the subject of compass correction.

But what of the check referred to, as deduced from celestial observation? The question of correction must be viewed under two aspects, namely, the *accuracy* and *labour* in the means employed. As a question of spherical trigonometry, its accuracy is mathematically sufficient; and, as regards labour, there are two ways of working, namely, by logarithmic *calculation* and by *construction*. The calculation of an azimuth is the resolution of a spheric triangle, in which certain things are given to find others: as in the following example, in which it was possible to use the horizon.

Suppose a ship to be in latitude 51° 30′ N., when the altitude of the sun's centre was 40° 25′, the sun's declination at the same moment being 20° 2′ N.: required the sun's true bearing and the error of the compass, the bearing of the sun by compass being S. 79° 39′ W.:—

Sun's declination . . .	20° 2′		
	90 0		
Sun's Polar distance	69 58		
Latitude	51 30	Log secant .	0·20585
Sun's altitude	40 25	" secant. .	0·11842
Sum	161 53		
½ Sum	80 56½	" cosine .	9·19711
Diff. between ½ Sum and P. dist.	10 58½	" cosine. .	9·99198
The true azimuth .	S. 69° 39′ W. =	Log sine square	9·51336
By compass . . .	S. 79 39 W.		
Error of compass . .	10 0 West.		

Or supposing the horizon obscured, and an altitude impracticable, take the following example:—

A ship in latitude 10° 20′ N.; sun's declination, 22° 14′ S.; the time of day, 1h. 44m. 17s.; the sun's bearing, N. 162° 3′ West: required the true azimuth and compass error?

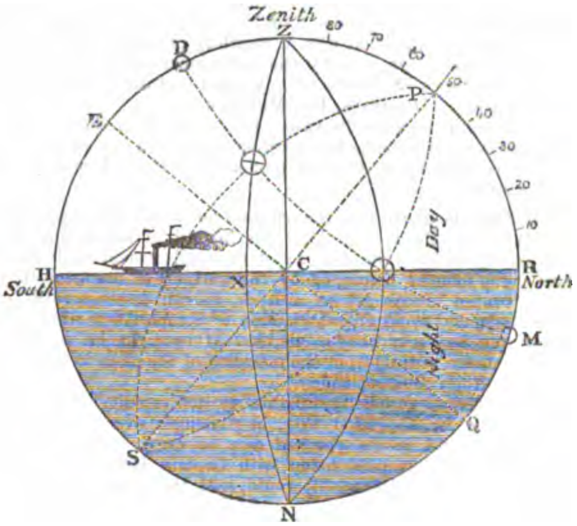
	H. M. S.				
Time . .	1 44 17				
Half . . .	52 8	cotangent	0·63548	cot.	3·63548
	90° 0′				
Sun's declination	22 14				
Polar distance .	112 14				
90° 0′					
Co. Lat. 10 20					
	79 40				
Sum . . .	191 54				
Difference . .	32 34				
½ Sum . .	95 57	secant	0·98439	co. sec.	0·00235
½ Diff. . . .	16 17	cos. .	0·98222	sine .	9·44776
	88° 34′	tan. .	1·60209	tan. 50° 37′	0·08559
	180 00				
Supplement .	91 26				
	50 37				
Sum, N. . .	142 3 W. = True azimuth.				
N. . .	162 3 W. = Sun's bearing by compass.				
	20 0 W. Error of compass.				

Such are the calculations in each case, and they are shortened when altitude and time are both known. Better even would it be to use in this manner a few extra logarithms daily, than to depend on a correcting-card. But there is another and more simple method, not generally known, of solving a spheric triangle with sufficient accuracy for an azimuth, where the nearest degree is enough, because one cannot steer a ship to within less than a degree or two: it is by *construction* of the spheric triangle. This process, however, would have its inconveniences, although it requires only a plane scale and a pair of dividers or compasses. But these inconveniences have of late been totally obviated by the invention of the spherograph [SPHEROGRAPH], in which, having any three elements of a spheric triangle, the others are found without any calculation, and in a very few seconds; indeed, the Astronomer-Royal has given his written opinion that "*for the special purpose of determining azimuths to correct a compass, he thinks the spherograph is excellent.*"

In anticipation of the word SPHEROGRAPH, a sketch of the instrument as it appears when finding an azimuth will in this place be sufficiently illustrative.

In the annexed figure the sun is represented as being just on the horizon, the dark lines of the drawing represent the upper sphere, and the dotted ones those of the under sphere as *seen through* the upper transparent one, both spheres being moveable on the centre C.

Suppose the latitude, say 50° N., to be represented by P R (equal to the height of the north pole of the heavens above the north part of the horizon), and the oblique circle P O S to represent the hour circle for 7 P.M., and the small circle D ⊕ O M to represent the sun in its distance from the equator (E Q), or, as it is called, the declination. For all nautical purposes the line D ⊕ O M may be called the sun's path in the heavens for that day. Now, the part of the circle R must have been moved on its centre C so as to place it 50° (the required latitude) from P: on the under sphere *no other movement is required:* but we see at a glance that the sun would be at M at midnight, at O when rising or setting, and at D when on its meridian. Hence, the degrees being all printed on the spherograph so as to enable all distances to be *read off*, no further *measure* or construction could be required, and we should in this instance find that C O on the horizon would measure the rising amplitude and O R the rising azimuth; and C being the east and R the north part of the horizon of the instrument, the sun would rise at about N.E. by E. Suppose it were required to correct the compass at any time of the day, say at 9 A.M., I should select the 9 A.M. hour circle P ⊕ S, as drawn on the under sphere of the spherograph, and notice where it crosses the parallel of declination D M at ⊕; and any vertical circle (suppose Z ⊕ N) which, passing through the intersection, cuts the horizon (as at X), would show the bearing in azimuth as measured at H X; and as H is at the south part of the horizon and C is at the east, C X would be very nearly east by south: if the compass showed by it that the sun was at the same time (for instance) E.S.E., the compass would have an error of one point.



It seems then that a possibility exists of totally avoiding accidents dependent on compass errors, and by a means sanctioned and approved by the Astronomer Royal; and although changes in magnetic condition cannot be foreseen and prevented, we in reality seem to be able, *by merely turning a transparent card on its centre*, and at any time, or at any part of the world, and by a process which occupies about ten seconds of time, when any heavenly body is visible, *and without requiring any observation for altitude*, to place an effectual check upon a compass.

In order therefore to put the question in a plain and available form for mariners, the following is proposed as a system applicable at all times to any compass, and on board any ship, be her magnetic condition whatsoever it may: and as this method of ascertaining a true azimuth from celestial observation is *totally independent of the horizon*, it is available in a few seconds whenever any heavenly body is visible, even in hazy weather, and is therefore much more convenient and expeditious, as it must be more accurate, than any swinging of a ship:—

1. As a mariner always knows his latitude and declination to the nearest degree, and his apparent time to the nearest minute or two, let him, when desirous of merely checking his compass, find at once the sun's true azimuth [BEARING] by the spherograph (or by construction or calculation, at pleasure), and compare the result with his compass bearing of the sun's centre.

   If his ship be at anchor, and he wishes to examine into her general local attraction, let him, *while she is swinging with the tide*, take the bearings of the ship's head as she comes to the several points of the compass, noting against each observation the apparent time at which it was taken: then let him seek against each of those times in the spherograph the corresponding true azimuth of the sun (the whole is done by one movement of the upper card of the spherograph on its centre), and by comparison the whole condition of the ship *for that day or period* is shown, and that too without the usual labour and expense and detention of the vessel during compass correction. As many as 300 bearings have been taken by the late secretary of the Compass Committee at Liverpool, while a ship has been swinging with the tide even in so quick and strong a river as the Mersey.

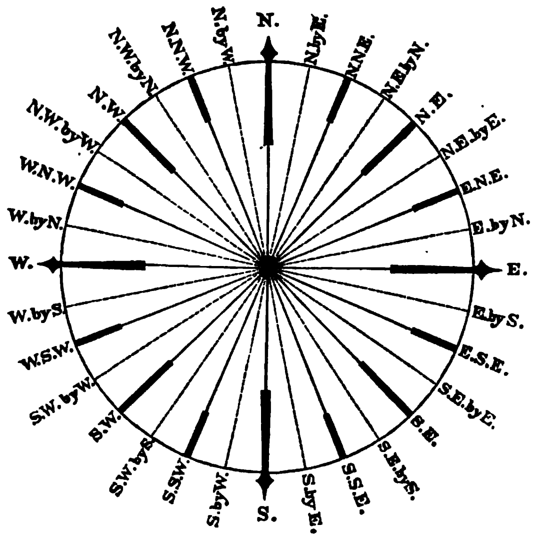
2. Either register the error so found in one of the admiralty forms of graphic delineation (Sir A. Smith's), or adjust the shifting magnets and soft iron by the astronomer royal's method, by the assistance of Gray's or any other apparatus for effecting this object. [COMPASS, THE MARINER'S.]
3. Let the ship occasionally yaw a few points from her course at least once a day, using the spherograph, and in case of suspected bad weather, up to the last moment at which a heavenly body is visible.

By following the above plan the compass need no longer be a source of anxiety to an officer of a ship; for instead of his having, as at present, to depend on an erroneous system of adjustment made in port perhaps many months before, or by the working of an azimuth, for which he cannot always get an altitude, he can dispense with both these methods, and avoid all calculations or complexities whatsoever, whenever any heavenly body is visible. If by night, he would use the star's distance in time from the meridian of the place as if it were in the spherograph apparent time.

From the extreme simplicity, infallibility, and rapidity of the above method, it may be suggested that, in passenger over sea steamers, the compass ought to be checked *once in every watch;* for this purpose a common compass, fitted with Captain Robertson's patent "deviation detector" [BEARING], would, with the spherograph, be all-sufficient.

COMPASS, NOTATION OF. The notation of the mariner's compass is very simple. If we divide a circle into four equal parts, each of the points which separate those parts may be called cardinal. Pliny called one of these the *cardo mundi*, or the pole of the world, meaning the north pole. Another ancient author speaks of the *cardo cœli*, or the pole of the heavens, meaning also the north pole; while Quintilian speaks of the *four* as the *quatuor cardines mundi.* Hence, by common consent, the north, east, south, and west are called "cardinal points."

The formation of the compass card will be easily understood by the following:—



Let N.E.S.W. represent the cardinal points. The point midway between them is formed by combining the letters; thus, taking the quadrant or quarter of a circle which lies between N. and E., the intermediate point will be called N.E. If we halve this distance, N. and N.E., we call the middle point N.N.E. If we halve now the distance, N. and N.N.E., we call it N. b. E. (or north by east, or north *towards* east, for any further combining of letters would be inconvenient). In like manner we divide N.E. and E., and the intermediate point will of course be E.N.E. (the nearest cardinal point always stands first when we combine the letters); and again, halfway between E.N.E. and E. would be E. b. N. (or east towards north). It need only to be remembered that the cardinal points, *and* the midway points between them, such as N.E., S.E., N.W., S.W., always have the word "by" or "b." in the points next to them. The other three quadrants are formed in precisely a similar manner. We thus find the circle divided into 32 parts or points; and as the whole circumference of a circle is divided into 360 degrees, 360 divided by 32 will give 11° 15′, or 11¼ *degrees*, as the angle which each point makes at the centre of the compass.

When using a compass card, the observer should always consider himself as *at the centre of it,* and not outside the circle; for the centre of the compass card represents the point of the earth on which he is standing, and the visible horizon may be considered to be represented by the outer rim of the card, on which the degrees are generally marked.

The direction in which an object lies is called its bearing. [BEARING.]

COMPASSES. This term we suppose to be synonymous with *compassers,* instruments by which we compass or go round a space. We shall here only give such a general notion of differenf kinds of constructions as will perhaps suggest the most convenient for any particular purpose.

1. *Common Compasses,* or *Dividers.*—These are simply two pointed legs on a common pivot, for transferring distances. For drawing a circle the lower end of one of the legs is removed, and its place supplied by a holder for a pencil, or by a steel pen.

2. *Hair Compasses.*—One of the legs has a part attached to the upper part by a spring, so that by means of a screw a very small motion may be given to the lower end. It is convenient for very accurate dividing, but must be used with care.

3. *Triangular Compasses.*—These have three legs and two pivots, so that the three points of a triangle can be at once transferred. This is useful only in rough work, as the instrument is difficult to handle.

4. *Proportional Compasses.*—These consist of two dividing compasses with a common pivot, which, when open, present vertically opposite angles; consequently, the intervals between the points of one and the other are in the same proportion as the legs of one to the legs of the other. The pivot is a clamping screw, which can be transferred along the interval between the pairs of points, and a scale points out how to adjust the instrument so as to alter any line, or surface, or solid, in a given proportion. These compasses sometimes have an apparatus for slight adjustment; but on the whole we consider it as an instrument for rough work.

5. *Beam Compasses.*—This instrument is a cylindrical bar, perpendicular to which, with clamping screws, slide a point and a pencil. The use of it is to describe large circles, or to measure large distances, the common compasses being very liable to slip when opened very wide. It is a safe and sure construction.

6. There is a method of describing a small arc of a very large circle, as follows: An elastic rod of metal is furnished with a rigid bar, on which it can be drawn up by screws, so that the rod shall form an arc, the chord of which is a part of the bar. This may be adjusted so as to pass through three given points nearly in the same straight line, and though the curve then described by guiding the point of a pencil along the rod be not exactly an arc of a circle, yet, for all small flexures, it will come sufficiently near for practical purposes.

7. *Caliper Compasses,* or callipers, are compasses intended to measure the calibre or diameter of round bodies, and are formed with curved legs, knobbed instead of pointed. Being opened until the body to be measured can only just pass through them, the distance between the two internal extremities of the knobs is of course the diameter of the body.

Many other species of compasses have been constructed, but the above are the principal ones in common use. [ELLIPTIC COMPASSES.]

COMPLEMENT, that magnitude which, with another, makes up a given magnitude. This is the general meaning of the term; but the most usual specific uses are as follows: Complements of the parallelograms about the diagonal of a parallelogram: through a point in the diagonal draw parallels to the sides; the whole is then divided into two parallelograms on the diagonal, and two which only touch the diagonal at one angle. The latter pair are called by Euclid complements to the former.

The complement of an arc or angle is the arc or angle by which it falls short of a quadrant or a right angle.

The complement of a logarithm is the number by which a logarithm falls short of 10: thus comp. log. 2 is 10 — ·30103 or 9·69897.

The arithmetical complement of a number is the number by which it falls short of the next higher decimal denomination. Thus, ar. co. 936 is 1000 - 936, or 64; arith. comp. of 83 is 100 - 83, or 17. Beginning from the left, subtract every figure from 9, up to the last significant figure, which subtract from 10.

For the complement of life, see DE MOIVRE'S HYPOTHESIS.

COMPLEMENTARY COLOURS. [LIGHT.]

COMPLUTENSIAN POLYGLOTT. [BIBLE.]

COMPOS, or NON COMPOS, MENTIS. [INSANITY.]

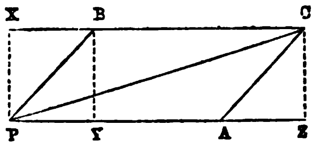
COMPOSITE ORDER. [COLUMN.]

COMPOSITION. In the gradual progress of mathematical language, this word has acquired a general meaning, as follows: Any one magnitude is said to be compounded of two others, when it produces the same effect as the other two put together. For instance, if we increase a length in the proportion of 3 to 7, and then increase the result in the proportion of 2 to 5, the original line is increased in the proportion of 3 × 2 to 7 × 5, or of 6 to 35. Hence the proportion of 6 to 35 is said to be the proportion compounded of (out of) the proportions of 3 to 7 and 2 to 5.

The effects of which it is in our power to form a distinct conception are of two kinds: 1. Those in which there are only two kinds imaginable, and those two diametrically opposite, with one neutral intermediate state. 2. Those in which the diametrically opposites have an infinite number of intermediate gradations. Loss or gain of money is an instance of the first; change of direction of the second. If, at the rate of an inch to a shilling, gains were measured northward from a given point, and losses southward, we could immediately make it a necessary consequence that the balance, if any, is represented by a line northward or southward, according as it is for or against. But draw a line eastward, and it will readily be admitted that such line will not present itself in any necessary connection with a sum lost or gained, or neither lost nor gained. For if the latter, why should a line eastward be preferred to a line westward, or in any other direction?

An immense number of modes of composition will readily suggest themselves, in which addition and subtraction are the processes by which composition takes place. If I go three miles northward, and then two miles farther, I go in all 3 + 2, or 5 miles northward. Other modes, as in the instance first given, will suggest themselves, in which multiplication and division are the compounding processes, and so on ad infinitum. These are all cases in which magnitude only is concerned; but whenever we have both magnitude and direction, it is plain that we have now both magnitude and direction to consider in the effect. If I go a mile northward and then a mile eastward, the whole effect, as to direction, will be, that I go to the north-east; as to magnitude, that I go not two miles, but only $\sqrt{2}$ miles, or 1·414 miles very nearly. Here is an instance in which the components are represented in magnitude and direction by two sides of a triangle, while the total effect is similarly represented by the third side. In the article CENTRE will be found various instances in which the meaning of that term implies the point at which a single action must take place, which will produce the same effect as a number of different actions produced on a number of points.

In mechanics, we have to consider the combined effects of different velocities, pressures, momenta, rotations, &c., communicated at the same moment of time to the same body. In all, the law of composition is found to be as follows:—



In what sense soever the actions at P can be represented in magnitude and direction by PA and PB, in that same sense can the joint effect be represented by PC, the diagonal of the parallelogram, in both magnitude and direction: or PA and AC being the actions (AC being equal to PB in magnitude and direction), PC, the third side of the triangle, is the united action. Thus, if at the same instant we communicate motion to P in the directions PA and PB, with velocities PA and PB per second, we thereby merely communicate to P a velocity PC per second, in the direction PC. The same holds of momenta and pressures; and even if we give P two separate rotations, which would separately carry it round the axes PA and PB in angles per second which are in the same proportion as PA and PB, the joint effect is a rotation round the axis PC with an angle per second which is to the angle of PA (or PB) as PC is to PA (or PB).

We have here not to prove these things, but only to illustrate the word composition. But this we must remark, that our preconceived notions will never allow us to say that A is the effect of P and Q, and B of R and S, unless the application of P, Q, R, and S together will be the same in effect as that of A and B together. We shall show that this necessary condition of our notions of cause and effect is preserved in the method of composition just described. Let PX, BY, and CZ be parallel to each other; then, if our law of composition be general, PB is the effect of PX and PY. Therefore PX, PY, and PA should be together equivalent to PC. But AZ is equal to PY, and PZ is therefore equivalent to PA and PY. Therefore AC should be the effect of PZ and PX, which we immediately see it is, being as much the diagonal of PXCZ as it is of PBCA.

As another, and a very curious instance of composition, we shall notice the following: Suppose x and y are to be measured, and both are subject to error, every error entailing loss in proportion to its magnitude, and causing equal loss, whether it be an error of excess or an error of defect. Suppose also that the errors are of such a kind that the average of any number of measurement is more probably right than any other. Let a and b be the sums which it would be equitable to pay for insuring x and y, that is, which should be given to any one who would agree to bear the loss on x and y separately. The sum which should then be given to one who would bear the total loss arising from the possible error in $x + y$ is not $a + b$, as might at first appear, but $\sqrt{a^2+b^2}$, or the hypothenuse of a right-angled triangle of which a and b are as the sides.

Our limits will not allow us to enlarge on this subject; we shall add the two following remarks.

1. The fact of the law of composition being the same both for velocities and pressures, has caused many writers on mechanics to confound the two, as if the one proved the other, which is neither true, nor even *very* probable. And other writers on mechanics, while proving this general law, that actions which can be represented by the two sides of a triangle produce an action which can be represented by the third side, have restricted the proposition, and seem to imagine that what they prove is true of *forces* only. This, with great deference to such a writer, we conceive M. Poisson to have done in the well-known proof at the beginning of his mechanics, a work which we may take this opportunity of saying, we hold in higher estimation than any other elementary mathematico-physical work whatsoever.

2. The difficulties of negative quantities in algebra arose from a want of generality, which gave rise to the attempt to express composition by addition only or by subtraction only, where either addition or subtraction might be requisite; and the difficulties of impossible quantities arose out of a similar deficiency, bearing the most complete analogy to trying to compound in magnitude only, in cases where both diversity of magnitude and of direction should have been considered.

COMPOST. [MANURE.]

COMPOUND, that which results from composition. [COMPOSITION.]

COMPOUND ADDITION. [ADDITION.]

COMPOUND INTEREST. [INTEREST.]

COMPOUND QUANTITIES [ARITHMETIC], quantities in which more than one unit is employed, as in 2 pounds, 3 shillings, and 6 pence: 2 miles, 3 yards, and 4 inches.

COMPOUND RADICALS. A term applied in chemistry to those combinations of elements which act towards oxygen, hydrogen, and acids, as simple elements. [ORGANIC RADICALS.]

COMPOUND RATIO. [COMPOSITION; RATIO.]

COMPOUNDING OF A FELONY. [FELONY.]

COMPRESSIBILITY OF WATER. [ELASTICITY.]

COMPURGATOR. In the middle ages a practice prevailed, derived from the canon law, of permitting persons accused of certain crimes to clear themselves by purgation. In these cases the accused party formally swore to his innocence, and, in corroboration of his oath, twelve other persons, who knew him, swore that they believed in their consciences that he stated the truth. These twelve persons were called compurgators. (Ducange, 'Juramentum.') This proceeding appears to have existed among the Saxons, and, in process of time, it came into use in England in civil cases of simple contract debts. [WAGER OF LAW.] The ceremony of canonical purgation of clerks-convict, which was nothing more than the formal oath of the party accused, and the oaths of his twelve compurgators, continued in England until it was abolished by the stat. 18 Eliz. c. 7. [BENEFIT OF CLERGY.] (Blackst. 'Comm.,' Dr. Kerr's edit., vol. iii., 364; iv., 434.)

COMPUTATION. We need not tell those who are acquainted with the existing treatises on arithmetic, that in no one instance do they pretend to give any mode of forming good habits of computation. The beginner, after receiving instructions as to what is to be done in the several great rules of arithmetic, is allowed to manage the details as he can.

The mere mechanical art of computation, apart from arithmetical reasoning or application to subjects of interest, is no very lofty exercise of the mind. A wonderful degree of proficiency in it can be attained by many who find connected reasoning almost an impossibility; and on the other hand, some of the first among mathematical discoverers have hardly arrived at more than the expertness of an ordinary schoolboy. It is one of those arts among many which are accessible to all who begin with a determination to conquer difficulties, and a power of arriving at methodical habits: no person who, after beginning in the right way, is obliged to confess a total failure, has any ground to suppose that he could master a common manual art: he may be a genius, but nothing could make him a weaver. That we may not frighten any one of the thousands who are miserable computers after going through years of school discipline, and whose minds are too well made to allow them to flatter themselves that they were above it, it is but fair to say that very few are allowed to begin in the right way. Every merely mechanical business must be learned by a sufficient repetition of the most purely elementary steps. A discipline of the mind may be taken up at the wrong place, and still be a discipline, though not so perfect as it might have been. But in what is merely art, nothing can compensate for the want of habit of operation duly learned at the proper time. Now computation is only an art: its elements are a small number of acts of memory: its details consist in a still smaller number of operations, each of which, by itself, is of the utmost simplicity.

Many readers will suppose us, in speaking of the elementary rules of arithmetic, to mean addition, subtraction, multiplication, and division, as given in the books: but we should as soon think of saying that the elementary operations of a journeyman tailor's business are the making of coats, waistcoats, and trowsers. The rules just named are the perfection of computation, not its commencement: he who can do them all with ease and accuracy is a calculator. The fundamental operations of which we speak are to those elaborate processes just what threading a needle and drawing a stitch are to the making of a coat. We can carry the comparison still further: and its justice is not accidental, but the necessary consequence of the resemblance of all mechanical operations. We do not say that a workman who is capable of joining two pieces of cloth together with strength and neatness is a finished tailor: he cannot therefore choose cloth, cut out cloth, imitate fashions, but he can follow directions, and he is the man who actually makes the coat. Nor do we mean that the person who can merely perform the four rules is a complete arithmetician: he cannot know how to apply those rules, he has not learned how to think of their uses. But, under directions, he can really manage the last and executive process of any mathematical inquiry. Until he is something better, he is but a tool in the hands of others, but no one thinks the less of tools because they cannot work of themselves.

Is this then, we shall be asked, all that you propose, namely, to describe addition, subtraction, multiplication, and division? We answer, yes, and on these simple grounds, that nothing more is wanted, and that in what we have to say upon them, we shall touch the reason why so many persons are incapable of and disgusted with arithmetical process. There are but few who find much difficulty in comprehending what is to be done in a question of arithmetic: but there are many who find that, however clearly they may see the way, there is a heavy and broken ascent between them and the answer. The figures will not come right, there is nothing but mistake after mistake: and though everything else is gained, the result is not. Few of those who are thus perplexed are aware that nothing is wanting but attention to the elementary processes with a better method than a beginner invents for himself: every one knows that books and teachers give no method at all.

The following system of exercises constitutes the whole of what is necessary. The degree of attention with which each is to be practised must depend upon the circumstances of the learner's case. Each one contains a difficulty which most persons will suppose they could avoid, some in one manner, some in another. Their several suppositions are true; and it is just as true that the trouble and risk with which an infant learns to walk upon its feet could be avoided; some could continue to crawl, others could contrive to walk on their knees; all would get on in a certain manner. Any person who is determined to succeed, and who has reason to know that his method has not answered as yet, should try our plan with the faith of a learner. But we can promise him no success unless he will make up his mind, from the outset, entirely and at once to abandon every habit which we condemn, and to adopt every mode which we prescribe: and this, though it should seem to him that what he has to take up is more difficult than what he is to leave off. He may take any time, and must not be discouraged by finding that the new operations are at first longer than the old ones. He must continually attempt more and more rapidity, remembering that quickness of operation will never come of itself by practising with deliberate caution. Slow and sure is better than quick and wrong, no doubt, if one or the other must be the end of it; but *quick and sure* must be the motto of an arithmetician. All very correct computers that we have seen have been rather rapid workers: we believe the reason to be that those who cannot acquire rapidity give it up in disgust.

1. Presuming that the learner can count one, two, three, &c., as fast as he can speak the words, he must then try if he can do the same backwards, as fifty, forty-nine, forty-eight, forty-seven, &c. He must then practise counting forward—by two at a time, as in 2, 4, 6, &c., 1, 3, 5, &c.—by three at a time, as in 1, 4, 7, &c., 2, 5, 8, &c., 3, 6, 9, &c.—by four at a time, as in 1, 5, 9, &c., 2, 6, 10, &c.—and so on up to 11 or 12 at a time. The same should be done backwards, as in the following by sevens, 90, 83, 76, 69, &c. In doing this he must not use any description, either vocal or mental: it must not be 22 and 6 are 28, 28 and 6 are 34, &c.; but 22, 28, 34, &c. These various processes should be carried to or from 100 at least.

2. Proceed to form with rapidity the number which must be added to a given number to make up the next number which ends with a given digit. Thus, one of the questions asked, at its fullest length, is "Given 38 and 4, how much must be added to 38 to give the next number that ends with 4." But all that must be repeated, orally or mentally, is "38 and six are forty-*four*." Write down a row of numbers, as in

7 2 9 6 3 2 8 4 1

and practise thus:—72 and 7 are 79, 29 and 7 are 36, 96 and 7 are 103, 63 and 9 are 72, &c.; taking 72, 29, 96, &c., for the successive lesser numbers, and 9, 6, 3, &c., for the successive unit figures of the greater numbers.

3. Endeavour occasionally, in the exercise immediately preceding, and in those which follow, to fix the thoughts particularly upon the *tens* of the result. It will generally happen that the units are immediately to be written down and discarded, while the tens are to be retained in memory. Practise repeating a number, so as while repeating it to write down the units and think of the tens: thus, in 76, at the moment of writing down 6, think of 7.

4. Learn the multiplication table up to 12 times 12, but not with the usual practice of wording all the results, as in "7 times 8 make 56," "4 times 5 are 20," &c. The table must be so learnt that the two factors suggest the product instantaneously. Thus, 8 and 9 must give 72 the instant they come together in the mind; and so on. Take a row of numbers as before, and looking at the successive pairs, repeat the products. Thus, 2 9 8 7 4 3 5, &c., is to suggest 18, 72, 56, 28, 12, 15, &c., as fast as the words can be spoken. Those who have been accustomed to learn the multiplication table from the half of it, always putting either the greater factor first, or else the lesser, must now accustom themselves to the whole: 5 and 9, or 9 and 5, must suggest 45 with equal ease.

5. Augment the last exercise as follows:—Having three digits learn to pass in thought immediately to the product of the first two augmented by the third; thus 7, 9, and 8 must lead to 7 times 9 increased by 8, or 71. Take a row of figures, as before, say, 2497163, &c., which must be made the means of suggesting immediately 17, 43, 64, 13, 9, &c. The usual repetition, "twice 4 are 8 and 9 are 17," &c., must not be tolerated for one moment.

6. Acquire the power of combining the fifth and second exercises as follows:—Having four digits, learn to add the third to the product of the first and second, and to pass on to the next number which has the fourth in its unit's place. Thus, with 7, 8, 5, and 0, think of 61 (7 times 8 and 5), as in the last exercise, and as in the second, get "61 and 9 are 70." Repeat only as much as is in the last phrase, dealing with the first three numbers by the habit acquired in the last exercise. Thus, with the row of numbers 19728663, &c., should be rapidly suggested—16 and 6 are 22, 65 and 3 are 68, 22 and 4 are 26, 54 and 9 are 63, &c.

7. Having four numbers, deal with the first three as in the fifth exercise, and then repeating the result, add the fourth. Thus, from 2, 7, 5, 8, get 19 and 8 are 27. Thus, the row of figures 7984361, &c., must give—71 and 4 are 75, 76 and 3 are 79, 35 and 6 are 41, 18 and 1 are 19.

8. Having a digit and a number of two places, learn to arrive speedily, and with few words at the number of times which the second contains the first (when not more than 9), and at the remainder. Thus, "7 in 53, 7 times and 4," "8 in 29, 3 times and 5," &c.

A person who really desires to become a good computer *must* arrive at the power of performing these exercises easily, quickly, and accurately. It is possible to dispense with them, and it is possible to dispense with rules and numerals altogether and to use pebbles. But we are very confident that when these exercises are once made very rapid and safe, the computer has gone through nine parts out of ten of his training: he can walk, and will soon learn to find his way. The common error lies in imagining that learning to find the way is learning to walk.

We now take the four rules, insisting on the details of the mode of performing each of them, and presuming the usual process to be known.

Numeration.—Learn to distinguish tens, hundreds, &c., not by the places in which their digits come, but by the numbers of places which come after those places. Instead of connecting thousands in the mind with the *fourth* place, connect them with *three places cut off.* Thus 176493 has 1764 hundreds, 176 thousands, &c.

Addition.—Add as in exercise 1; thus, if the figures were to be 7 2 8 4, &c., it should not be 7 and 2 are 9 and 8 are 12 and 4 are 16, &c., but 7, 9, 12, 16, &c. Dwell upon the tens to be carried, in writing down the units. In the following question, every word that should be repeated, orally or mentally, is written down, and each figure that is to be written down is marked with an accent; each ten that is to be dwelt on for a moment is in italics:—

27649	8, 17, 22, 30, 36, *forty*-five′
9276	10, 19, 20, 27, *thirty*-one′
308	11, 18, 24, 27, 29, *thirty*-five′
44615	3, 5, 9, 18, *twenty*-five′
2799	3, 7, nine′
10868	
95515	

Let the method of verification be simply taking the columns in the opposite order, or downwards, as 9, 15, 23, 28, 37, *forty*-five′, &c.

Subtraction.—Let the several subtractions be made by mental recovery of additions as in exercise 2: not "7 from 16 leaves 9," but "7 and 9," not repeating 16, which is unnecessary, inasmuch as when 9 is found, 16 is done with, and the carriage of one is all that is to be remembered. The following detail has every word of the process:—

274631807	8 and 9′; 5 and 5′; 10 and 8′; 9 and 2′; 2 and 1′;
95318948	3 and 3′; 5 and 9′; 10 and 7′; 1 and 1′.
179312859	

According to even recent books the computer should say, "8 from 7 I cannot, but 8 from 17 and there remains 9, set down 9 and carry one," &c. It would be shorter than this to say, "8 from the next higher number that ends with 7 leaves 9." Our plan is the abbreviation of "8 and 9 make up the next number that ends with 7" repeating only the first three words.

Multiplication.—Apply the exercises 4 and 5 to the usual process. Here, as before, the detail given has every word which need be repeated. The figures to be written down are accented; all others are carried.

```
   7296 | 54', 86', 26', 6'5';  30', 48', 14', 3'6';  48', 76,' 23', 5'8 ;
    859 |    4'; 6'; 8, 16, 22'; 8, 12, 17'; 4, 10, 16'; 9, 12'; '6.
 ------ |
  65664 |
 36480  |
58368   |
------- |
6267264 |
```

The usual process of *casting out the nines*, as it is called, though not an absolute verification, is a useful one. Without entering upon its demonstration, we describe it.

Casting out the nines, means adding together the digits of a number and throwing out 9 as fast as it arises. Thus in 26647895 we have—2 and 6 are 8 and 6 are 14, throw out 9 and 5 remains; take in the next figure 4, giving 9, throw out 9 and 0 remains; then 7 and 8 are 15, throw out 9 and 6 remains; pass over the 9 and take in 5 which gives 11, on which two remains. All that is necessary to be repeated is 2, 8, 14, 5, 9, 7, 15, 6, 11, 2. Cast the nines out of both factors, multiply the results, and cast out nines; the answer should give the same figure as the reputed product gives when the nines are cast out. Thus 7296 and 859 give 6 and 4, the product of which is 24, giving 6: and the reputed product 6267264 also gives 6. This is a high presumption that the result is correct: the error, if any, lies in this, that the figures of 6267264 which are too great are exactly compensated by others which are too small. Now it is very unlikely that this exact compensation of errors should exist; and in this unlikelihood consists the strong presumption of verification which the rule of casting out the nines affords.

It may be observed that this rule applies to all operations, thus:—Do with the result of casting out the nines the same as was done with the numbers from which the nines were cast out; the answer, with its nines cast out, should give the same result as arises from casting out the nines of the reputed answer. Thus in the previous example of addition, the nines cast out from the several numbers to be added give 1, 6, 2, 2, 0, 5, the sum of which, with nines cast out, is 7, the same as from the reputed answer 95515. In subtraction, it may be necessary to *take in* a nine before subtracting.

Division.—This rule is considerably shortened, and (in our opinion, though we think many would differ from us) increased in safety, by performing each subtraction without setting down the multiplication. As a preliminary, suppose it required to subtract 7 times 29398 from 410843. Beginning with 7 × 8 instead of putting it down as 56, look at 3 and pass from 56 to 63, writing down the 7 and carrying the 6 tens just used. Take these 6 tens and 7 times 9, giving 69, and make them up to 74, putting down the 5, and carrying 7. All that need be repeated is as follows, dwelling on the tens carried:—

```
From 410843      | 56 and 7' make 63;  69 and 5' make 74;
Take  29398 × 7  |   28 and 0' make 28;  65 and 5' make 70;
      ------     |   21 and 0' make 21; 2 and 2' make 4.
      205057     |
```

Suppose 3293614829 is to be divided by 47698. Instead of the usual plan, write the divisor on the left, or the quotient on the right: at any rate, the divisor and the quotient should be near one another.

```
  Divisor 47698)3293614829
Quotient 69051   431734
                  245282
                    67929
                    20231 remainder.
```

The work is as follows:—The first quotient figure being 6, subtract 6 times 47698 from 329361, thus: 48 and 3′ are 51, 59 and 7′ are 66, 42 and 1′ are 43, 46 and 3′ are 49, 28 and 4′ are 32. The 4 being brought down, and 9 ascertained to be the next quotient figure, we have 72 and 2′ are 74, 88 and 5′ are 93, 63 and 4′ are 67, 69 and 2′ are 71, 43 and 0 (unnecessary) are 43. Then 8 and 2 are brought down, 0 and 5 written as quotient figures, and 40 and 2′ are 42, 49 and 9′ are 58, 35 and 7′ are 42, 39 and 6′ are 45, 24 and 0 are 24. The last quotient figure is 1, and 8 and 1 are 9, 9 and 3′ are 12; 7 and 2′ are 9, 7 and 0′ are 7, 4 and 2′ are 6.

Casting out the nines, the products obtained from the divisor and quotient, increased by the result of the remainder, ought, after casting out nines, to agree with the dividend. Here the divisor gives 7, the quotient 3, and the remainder 8: 7 times 3 and 8 is 29, giving 2; the dividend also gives 2.

We have put down every step of the work in all the rules. The very basis of this method is the acquisition of such expertness in the previous exercises as will enable the computer to dispense with a large quantity of the ordinary halting-places. We need not enter upon the rules for the extraction of the square and cube root [SQUARE], or of the solution of equations [INVOLUTION AND EVOLUTION], at length; but we shall annex an example of each, leaving the reader to apply the seventh exercise in its proper place. In the contracted part of Horner's method, we add to the method of the last article cited, a provision for making the first figure on the right of the vertical line of contraction as correct as the process will allow it to be. This last process (Horner's method) is the best exercise of computation. It involves all rules in a form of considerable detail and dispersion.

First, we put down the process for the extraction of the square root of 157.

```
      1̇57̇)12·52996408614166778849587
22      57
245     1300
2502     7500
25049    249600
250589    2415900
2505986    16059900
25059924    102398400
2505992808   21587040000
25059928166   153909753600
250599281721   355018460400
2505992817224 10441917867900
2505992817228    417946599004
  ...........    167347317281
                  16987748248
                   1951791345
                    197596373
                     22176876
                      2128934
                       124140
                        23900
                         1347
                           94
                           19
                            1
```

Now let it be required to find the positive root of $x^3 + x^2 - 12x - 12 = 0$.

```
1   1          —12              12(3·4641016151377545871
    4           0               12000
    7           2100             1936000
  100           2516              126664000
  104           294800              3142656000
  108           301556                 49953279000000
  1120          30834800               19025101177699
  1126          30880336                 468188547708
  1132          3092588800               158901517715
  11380         3092702721                 4260501864
  11384         30928166430000             1167681541
  11388         30928177822801              239835444
  113920        30928189214603               22338022
  113921        30928196049985                1688280
  113922        30928202885367                 141870
  11392300      3092820299929                   18157
  11392301      3092820311321                    2693
  11392302      309282031702                      219
  11392303      309282032272                        3
                .........                           0
```

In both these examples the result is carried to about three times as many figures as are usually wanted. But this is what should be done in computing for exercise. No one does his very highest with ease or with certainty; and a person who can safely and rapidly knock off the seven or eight figures which are generally requisite must be one to whom a much larger amount of correctness is, or has been, familiar.

It is necessary to insist particularly upon acquiring the habit of rapid computation by attempts at rapidity. Taking any exercises which verify one another, as a multiplication and a division, or a raising of a square and extraction of the square root, the learner who has acquired a little familiarity with the rules should try them at the top of his speed. If the verification be attained; if the division, for instance, reproduce the multiplier for a quotient, without remainder, it is thousands to one that the whole process is correct. But if there should be a failure, as may, and almost certainly will at first, happen several times running, there is no occasion to examine closely into the reason of the failure. The whole question should be thrown aside, and another should be taken. In this course it will soon appear that the attempts become more and more nearly correct, until at last failure is the exception, and not the rule. There must be no fear of error, whether there be cause for it or not. The young calculator should proceed as boldly as if he were infallible; for he may depend upon it, that it is not inaccuracy which is to be avoided by precaution, but accuracy which is to be obtained by habit.

With regard to minor points, every one must decide for himself whether actual vocal repetition of the words and numerals necessary to the process does or does not tend to accurate working. Some persons cannot compute without repeating to themselves; but it is worth while to give silence a fair trial. It would also be of assistance to some persons to invent a habit of signifying the multiplier, which is in actual use, by some arbitrary position of the left hand. Thus, 1, 2, 3, and 4 might be signified by placing the corresponding number of fingers of the left hand on the paper, 5 by placing the thumb only and 6, 7, 8, and 9 by the thumb, with a corresponding number of fingers.

In all those parts of computation which relate peculiarly to fractions, common or decimal, we know of no guide but reason. The ultimate process, the actual step for the time being, must be either addition, subtraction, multiplication, or division; and accuracy may be acquired mechanically. However desirable it may be that the learner should demonstrate these processes, his power of performing them does not depend upon his being able to do so. It is otherwise with regard to the new and distinct processes introduced in questions which require fractions; and which are in fact, not themselves processes, but directions for selection of processes.

The general run of commercial calculations hardly needs any distinct preliminary exercise. There is one great improvement of which ordinary methods are susceptible, namely, the expression of the parts of a pound decimally, instead of by shillings, pence, and farthings. Until a decimal coinage is obtained [STANDARD], any person with a moderate knowledge of decimal fractions may procure for himself most of its advantages, by the rules which are given in INTEREST, together with what we here subjoin. The demonstration will be easy enough to those who consider the fraction which one farthing is of a pound, ·0010416666 . . . . , or ·00104⅙.

To write down any fraction of a pound decimally, proceed as follows:—

Fill up the *first place* of decimals with 1 for every pair of shillings; and the *second and third places* with 50 for the odd shilling, if any, and 1 for every farthing in the pence and farthings, with an additional 1 if these amount to sixpence. Thus, as far as three places of decimals, 8*s*. is ·4*l*., and 9*s*. is ·450*l*.; 9*s*. 3*d*. is ·462*l*., 9*s*. 5½*d*. is ·472*l*., 9*s*. 6*d*. is ·475*l*., 9*s*. 8¾*d*. is ·486*l*.

Fill up the *fourth and fifth places* with 4 for every farthing above the last sixpence, and an additional 1 for every three halfpence. Thus, as far as five places of decimals, 9*s*. 3*d*. is ·46250*l*., 9*s*. 5½*d*. is ·47291*l*., 9*s*. 8¾*d*. is ·48645*l*., 9*s*. 10¼*d*. is ·49270*l*.

Fill up *all the remaining places* with the decimal fraction derived from the number of farthings above the last three halfpence for a numerator, and 6 for a denominator. Thus, 9*s*. 3*d*. is completely expressed in ·4625*l*., 9*s*. 5½*d*. is ·472916666 . . . .*l*., 9*s*. 8¾*d*. is ·4864583333 . . . .*l*., 9*s*. 10¼*d*. is ·492708333 . . . .*l*., 10*s*. 0¾*d*. is ·503125*l*., 3*s*. 3½*d*. is ·164583333 . . . .*l*.

For the most part three places are sufficient; and it is rarely that more than five are wanted. The inverse rule, namely, that for reading off a fraction of a pound into shillings, pence, and farthings, is done from the first three places, within a farthing, by allowing a pair of shillings for each unit in the first place, another shilling for 50 (if there be so much) in the second and third places, and a farthing for each 1 that is left in the second and third places, deducting 1 if 25 or more be left. Thus ·12345*l*. is 2*s*. 5¾*d*., ·29933*l*. is 5*s*. 12*d*.* or 6*s*., ·267*l*. is 5*s*. 4¼*d*.

These rules look repulsive at first. None but those who have practised them until the transformation is easily made, can have any idea of the amount of labour which they save. They are in fact as good as a decimal coinage to those who have mastered them. Those who doubt of it may try the following question in the usual way, and compare it with the decimal mode.

When the government, for ease of calculation, proposed seven pence in the pound instead of 3 per cent., as an income tax, how much tax, to a farthing, did they give up on 100 millions of income? On one pound 3 per cent. is ·03, and seven pence is ·0291666666 . . . ., which falls short of the former by ·0008333333 . . . : and this, taken 100 million of times, is 83333·333*l*., or 83333*l*. 6*s*. 8*d*.

Some development of the reasons for the plan which forms the main part of this article will be found in the 'Companion to the Almanac' for 1844.

CONCAVE and CONVEX—CONCAVITY and CONVEXITY. A curve or surface is concave on the side on which straight lines drawn from point to point in it fall between the curve or surface and the spectator; that side is convex on which the curve or surface falls between such lines and the spectator. A surface may be either entirely concave, as the inside of a sphere, or entirely convex, as the outside; or concave in some directions and convex in others, as the surface of a dice-box, or that made by the revolution of an hyperbola about its minor axis.

CONCAVE LENSES. [LENS.]

CONCAVE MIRRORS. [MIRROR.]

CONCEALMENT OF BIRTH. [INFANTICIDE.]

CONCENTRIC, having the same centre; thus, concentric circles are those described about the same point.

CONCERT, in music, a performance of several pieces of either vocal or instrumental music, but commonly of both, by different voices, and on various instruments. The earliest concert of which we find any record is that of the *Filarmonici*, at Vicenza, which must have been founded previously to 1565; for in that year another society, the *Incatenati*, was joined to it. But to England is due the credit of having instituted the first regular series of concerts, under the title of *The Academy of Antient Music*, which had its birth in 1710, and continued to exist upwards of eighty years. The *Concert Spirituel* of Paris was indebted for its origin to an elder brother of Philidor, the well-known composer and renowned chess-player, who in 1725 obtained a licence for the performance of sacred music during Lent. This proceeded without interruption till the French Revolution. The year 1776 is distinguished in musical history by the institution of the *Concert of Antient Music*, which became the asylum of classical compositions at a time when fashion threatened their extinction, and has ever since proved a school of music of inestimable value, by keeping alive a taste for the finest productions of the old masters. In 1791, Salomon, the celebrated violinist, commenced a series of subscription concerts at the Hanover Square Rooms, for which he engaged Haydn, not only to write those twelve grand symphonies which are among the glories of the art, but to come to London to conduct their performance. These concerts continued to be given until 1796, when they ceased; and with them seemed to die away all relish for grand instrumental compositions. But in 1813, a party of eminent professors, with a view to rescue orchestral music of the highest class from the neglect into which it had fallen, formed themselves into a body under the title of the *Philharmonic Society*, and during that season they gave eight subscription concerts, the success of which, both as regards the main design and the support they received, was without any parallel. They constitute an era in the art, and by their continuance act powerfully in promoting the advance of music.

Our space will only allow us to name some few other concerts which have risen up in the British metropolis, flourished for a time, then fallen to decay. Bach (John Christian) and Abel, in 1763, established subscription concerts, which flourished for twenty years. These were succeeded by *The Professional Concert*, which, after a struggle, yielded to the enterprise and ability of Salomon. The *Vocal Concerts* of Harrison and Knyvett began in 1792 at Willis's Rooms, and were discontinued at the end of the season of 1794. They were revived in 1801 by Messrs. Bartleman, Harrison, Knyvett, and Greatorex, and were conducted on a much larger scale. Their success at first was great, but they gradually fell off, and in 1821 were finally abandoned. In 1808, and two following years, Mrs. Billington, Mr. Braham, and Signor Naldi had subscription concerts at Willis's Rooms, and were opposed by Madame Catalani at the Hanover Square Rooms. In 1823, a weak and futile attempt was made to establish *British Concerts*, for the performance of music by native composers. For the same purpose a society was founded in 1834, under the name of the *Society of British Musicians*, but it has entirely failed in accomplishing its object. In 1833, a *Vocal Society* of thirty professional members sprang up at the Hanover Square Rooms, and gave six concerts, consisting almost entirely of vocal music, ancient and modern, of every school. They were conducted on a principle so laudable that every lover of the art felt an interest in their success.

Among the more permanent concerts are those given by the pupils of the Royal Academy of Music, at the Hanover Square concert rooms, to which the public are admitted. Exeter Hall, Strand, is much used for performances of various kinds of music, chiefly sacred. The *Sacred Harmonic* society, established in 1832, holds its meetings in this hall, as does also the *London Sacred Harmonic* society, an offshoot of the former. The oldest society in London for the practice and performance of sacred music is the *Cecilian* society, established in 1785. There is also the *Choral* society, established in 1791. The *Royal Society of Musicians* was established in 1738, Handel being one of its earliest members and benefactors. It was incorporated in 1790, and its object is to relieve decayed musicians, their widows and orphans, which it does by means of a fund raised at various times by donations and bequests, and also by the proceeds of concerts and an annual festival given by the society. In 1839, the *Society of Female Musicians* was established for the relief of its decayed members, and the first concert for the benefit of the charity was given in June, 1840. We may also mention the *Madrigal Society* (1741), which has an annual festival in January in the Freemasons' Hall, with monthly meetings during the season for the performance of madrigals, motetts, &c. There is also the *Western Madrigal Society* (1840); the *Nobleman and Gentleman's Catch Club* (1761); the *Glee Club* (1787); the *Melodists' Club* (1825); the *Purcell Club* (1837); the *Round, Catch, and Canon Club* (1843); the *Abbey Glee Club*, founded in 1841, by some gentlemen who had received their musical education in the choir of Westminster Abbey; the *Adelphi Glee Club*, so named from having been founded in 1833 by two brothers. There is also the *Choral Harmonists' Society* (1834); the *Amateur Musical Society* (1846); the *Musical Union* (1845). Concerts are also given at the Crystal Palace, St. Martin's Hall, St. James's Hall, and other places in the metropolis; while there is scarcely a town in the kingdom that has not its musical societies, which occasionally give concerts. Birmingham, Liverpool, Bradford, Leeds, and Manchester, have their music halls, their organs, their resident performers, and choruses. Even so remote a town as Aberdeen has a new hall, an organ, and 500 chorus-singers. This success is in great measure due to the foreign method of training singers in large masses which was introduced into this country about twenty years ago, under government patronage, and ably carried out by Mr. John Hullah. In this method, not only is a rudimental musical education given, but vocal part music is taught in large classes. Teachers of the method have been scattered all over the land, so that, aided by the publication of cheap music, a wide-spread taste for good music has been diffused among the working-classes, and the teaching of music is permanently established in charity schools.

---

* When 49 is left in the second and third places, this mode gives the same as when 50 is left. The direct rule gives the exact truth or a little less, the inverse rule gives the exact truth or a little more; about one farthing more in the case here before us.

CONCERT PITCH, in Music, is the *pitch*—the degree of acuteness or gravity—generally adopted for some one given note, and by which every other note is of course, governed. *Concert-pitch* has frequently much varied, and musicians have hitherto (with one exception) made little if any effort to obtain a fixed standard, though so desirable, and so easily established. Many years ago, Fischer, of Berlin, ascertained that the number of vibrations per second in the pitch note A, in four celebrated Continental orchestras was as follows; *Berlin Theatre*, 437-$\frac{32}{100}$, the *Grand Opéra Français* at Paris 431-$\frac{34}{100}$, *Opéra Comique*, 427-$\frac{61}{100}$, and *Opera Italien*, 424-$\frac{17}{100}$, which would give for the pitch note C adopted in this country, 524-$\frac{78}{100}$, 517-$\frac{61}{100}$, 513-$\frac{13}{100}$, and 509 vibrations per second respectively. The Philharmonic C used in this country, is equal to about 500 vibrations per second. Some years ago, when Mr. Hullah introduced the Wilhelm method into this country under the patronage of government, he applied to Mr. Charles Tomlinson to adjust a standard tuning-fork, for the regulation of his classes. It was recommended that the natural C represented by 512 vibrations per second be adopted as the standard, that number being preferred from its being the power of 2, and, moreover a good mean between the 524 vibrations of Berlin, and the 500 of the Philharmonic Society. This recommendation was adopted, and during the last eighteen years many thousand tuning forks have been issued, all of which have passed through Mr. Tomlinson's hands. Hence it may be safely asserted that a uniformity of pitch has been attained throughout the country in the numerous classes taught on Mr. Hullah's method, such as has never before been approached or attempted. At the time we are writing, the Society of Arts, London, apparently quite unaware of what Mr. Hullah had been practising for eighteen years, have formed a committee of distinguished individuals, to consider the whole subject of concert pitch and to report thereon. The result of their deliberations, if any, will be given under the article TUNING.

CONCERTI'NA, a musical instrument invented by Professor Wheatstone, the principle of which is explained under ACCORDION. The concertina, in its simple form, claims priority of the accordion in point of date, though the former, in its highly improved state, and as now generally in use, was more lately introduced.

This instrument is composed of a bellows, with two hexagonal faces or ends, and on these are placed the various stops or studs, by the action of which air is admitted to the laminæ (or tongues, or steel bars) producing the sounds; and hereon are also fixed the thumb-straps and finger-rests. The finger-stops are in four rows, the two middle ones confined to the notes of the natural scale, the two external rows to the flats and sharps. Each sharp and flat is placed by the side of its corresponding natural note, and the instrument has, in addition to a complete chromatic scale, two other notes in each octave, whereby the chords in different keys are rendered more perfect than on the organ or piano-forte, and by which also the fingering of the various scales is rendered equally easy.

The concertina, when the bellows is extended, is twelve inches in length, and the sides are about six inches wide. Its compass is three octaves and three notes, commencing at G, the fourth space in the base, and thence ascending. Some instruments, however, are made with a higher, some a lower, scale. That which we here describe is called the *double-action concertina*, because two springs, or tongues, are given to each note, in order that the same sound may be produced, whether the bellows be pressed in or drawn out. The *single-action concertina* has but one spring, or tongue for each note, and it yields a sound only when the bellows is moved inwards; that is, pressed. But it is provided with a self-acting valve, in order that the bellows may collapse instantaneously, which closes while the latter is pressed, and opens to admit air when it is expanded.

There are also tenor and base concertinas: the compass of the first from C, the second space in the base, to C the second additional line above the treble: of the last, from the second additional line below the base, to the third space in the treble. [HARMONIUM.]

CONCERTO, in Music (an Italian word adopted in our language), a composition in which many performers play in concert, that is, in unison, but in which some one or two instruments take rather a more prominent part than the others. Such are the concertos of Corelli, Handel, Geminiani, Avison, &c. But from the latter part of last century the term has been applied to the species of composition written for one principal instrument, with accompaniments for a full orchestra. Of this description are the piano-forte concertos of Mozart, Dussek, Cramer, Beethoven, &c.; and the violin concertos of Viotti, Rode, &c. It must be observed, however, that in the concertos of Mozart and Beethoven the orchestral parts are so full and so essential, that those compositions may, if the expression is allowable, be designated as symphonies with a piano-forte part *obbligato*.

CONCHIOLIN. An azotised organic substance little examined, found in some species of shells.

CONCHOID (κογχοειδὴς, resembling a shell). This name was given by Nicomedes (in the 2nd century) to a curve, by which he proposed the finding of two mean proportionals, and the duplication of the cube. It is found in the commentary of Eutocius on the sphere and cylinder of Archimedes, and in the fourth book of Pappus.

This curve is described by a revolving line, which passes through a fixed point, and is always produced to meet a certain fixed line. On the revolving line, from the point at which it meets the fixed line, set off a given line both ways. The two points thus laid down trace out the upper and lower conchoid, two branches of the same curve. The lower conchoid has two points of contrary flexure, a cusp, or a loop, according as the given line is less than, equal to, or greater than the perpendicular from the pivot of revolution to the fixed line. Taking the pivot of revolution as the origin, and the perpendicular just named as the axis of x, the equation of the conchoid is,

$$(x^2 + y)(x - b)^2 = a^2 x^2,$$

where a is the given line, and b the distance of the pivot from the fixed line.

CONCINNOUS INTERVALS, in Music, are the various concords. [CONCORD.]

CONCLAVE (a Latin word, which signifies a private room) is the name given to the assembly of cardinals when they meet for the purpose of electing a pope. [CARDINAL.] The day following the last of the funeral of the late pope, the cardinals, after hearing a solemn mass de Spiritu Sancto, proceed to one of the pontifical palaces, generally the Vatican, where rooms have been prepared for each of them, and where they remain shut up till the election has taken place. The keys of the palace are left in the care of a prelate, chosen previously by the cardinals, and who is styled governor of the conclave. Each cardinal has with him a secretary, called conclavista, and two domestics. They meet once a day in the chapel of the palace, where a scrutiny is made of their votes, which are written and placed in an urn: this is repeated every day till two-thirds at least of the votes are in favour of one candidate for the pontifical chair, who is then considered as duly elected. Each cardinal in giving his written vote accompanies it by his name, written in a separate sealed paper, which is not opened till the pope is elected, when the names of the voters are made known. When the election is strongly contested, and the cardinals grow weary of being shut up in conclave, negotiations in writing are carried on between the leaders, and a compromise is entered into by which two or more parties, not being able singly to carry the election of their respective candidates, join in favour of a third person, who is acceptable to them all, or at least not obnoxious to any of them. This often gives an unexpected turn to the election. During the conclave the ambassadors of Austria, France, and Spain, have a right to put their veto each upon one particular cardinal, whose election would not be acceptable to their respective courts. The new pope being elected, and his assent being given, he proceeds to dress himself in his pontifical robes; after which he gives his blessing to the cardinals, who give him the osculum pacis (kiss of peace). After this the name of the new pontiff is proclaimed to the people, from the great balcony of the palace, and the castle Sant' Angelo fires a salute, and all the bells of the city of Rome ring a merry peal for one hour. (Calindri, 'Saggio Geografico Statistico dello Stato Pontificio,' 1832.)

Regulations for the conclave, and the mode of election, have been issued by several popes, beginning from Nicholas II., in the council of Lateran, in 1059, down to Gregory XV., by his bull of 1621, and Urban VIII. in 1625. In times of war or civil disturbance the conclave has been held in other places besides Rome; that in which Pius VII. was elected was held at Venice. Accounts of particular conclaves have been given by numerous writers who have treated of the history of the popes. (Meuschen, 'Cæremoniale Electionis et Coronationis Pontificum Romanorum,' Frankfort, 1732.)

CONCORD, in Music, two combined sounds which are universally agreeable to the ear. It is commonly held, that the more frequently the vibrations of two strings coincide, and—which amounts to the same thing—the lower the terms in which the proportions of vibrations are expressed, the more pleasing the concord; but the 4th, an interval much less agreeable than either the 3rd or 6th, is a formidable exception to those rules, proving their fallibility by the test of experience. Rousseau is of opinion—and we agree with him—that the pleasure afforded by concords is attributable to their source, namely, the perfect chord [CHORD], which is itself the product, or combination, of nature. This, and its inversions, furnish us with all the concords.

Concords are the 8th (or octave), 5th, 3rd, and 6th. Their ratios are, 2 : 1, 3 : 2, 5 : 4, 5 : 3. The two first are called *perfect*, because, as concords, not liable to any alteration by sharps or flats. The two last are called *imperfect*, because alterable.

The 4th has always proved a stumbling-block to writers on harmony, for the reason above alluded to; but as a component part of an inversion of the perfect chord, it has some claim to be admitted among the concords. A great and recognised authority of the modern French school, says, that it is treated as a discord in relation to the bass, as a concord in relation to the middle and upper parts. M. Catel, however, has not in this instance proved as correct as usual: except in the chords of $^{4}_{2}$ and $^{6}_{4}$, the 4th, as an inner part, is, and can only be, treated as a discord.

CONCORDANCE, "a book which shows in how many texts of Scripture any word occurs." (Dr. Johnson). More particularly, it is a dictionary or index of all the important words in the Bible, alphabetically arranged for the purpose of finding passages and of comparing the various significations of words. To critical interpreters this class of books is justly considered of the greatest utility, as furnishing an instrument by which the determination of the meaning of obscure expressions may be greatly facilitated by reference to all the parallel passages. "A good concordance," says Dr. Geddes ('Prospectus,' p. 71), "is undoubtedly the best means of understanding the Hebrew Scriptures." While the Bible remained in manuscript, and was not divided into chapters and verses, indices of the words and phrases could neither be formed nor used; but as soon as these divisions began to be made, the great importance of concordances, or alphabetical indices, was at once perceived, and several learned men employed much time and labour in constructing them. The compiler of the first concordance in any language was Hugo de St. Caro, or Cardinal Hugo, who died in 1262. The earliest concordance of the Hebrew text is by Rabbi Mordecai Nathan, printed at Venice in 1523. Its Hebrew title is, 'The Light of the Way.' It contains all the Hebrew roots, branched into their various significations, and is said to be the produce of ten years of incessant labour. A more correct edition was published at Basil in 1581, and a Latin translation by Reuchlin in 1556; but both the Latin and the Hebrew editions are extremely inaccurate. The errors are, for the most part, corrected in the work by Calasius, which combines the labours of Nathan and Reuchlin. It is entitled 'Concordantiæ Sacr. Bibliorum Hebr. et Lat.,' 4 tom. fol. 1621. The additions by Calasius consist of very learned and laborious etymological remarks. The reprint of this ponderous work in London in 1747-9 contains among its subscribers all the crowned heads of Europe, including the Pope. The work by the elder Buxtorf, 'Concordantiæ Bibliorum Ebraicæ nova et artificiosa methodo dispositæ,' &c., fol. 1632, is more correct than Nathan's; but the references are made by Hebrew letters, and to the Rabbinical divisions of the Old Testament. An abridgment of it, by Ravius, is entitled, 'Fons Zionis, sive Concordantiæ Hebr. et Chald.,' 8vo. 1677. Dr. John Taylor, under the patronage of the English and Irish bishops, published, in 2 vols. fol. 1754, 'A Hebrew Concordance, after the manner of Buxtorf, adapted to the English Bible.' It is a complete and useful book for the English scholar. The 'Concordantiæ Particularum Ebræo-Chaldaicarum,' fol. 1675, and 4to, 1679, by Noldius, Theological Professor at Copenhagen, is very valuable for the explication of passages dependent on the Hebrew particles, a comparison of which is made with the Greek. The best edition is that of Jena, in 4to, 1734, with a Lexicon of Particles, by Michaelis, extremely useful to the Hebrew critic. There is also the 'Concordantiæ Librorum Veteris Testamenti Hebraicæ atque Chaldaicæ' of J. Fuerstio, fol., Lips. 1840.

With respect to concordances of the Greek Septuagint, we may notice especially, Kircheri 'Concord. Vet. Test. Græcæ, Ebræis vocibus respondentes,' 2 tom. 4to, 1607; but the Hebrew being placed first, it is more useful for consulting the Hebrew than the Greek text. The most complete and accurate work of this description is Trommii 'Concord. Græcis Versionis dictæ LXX,' 2 tom. fol. 1718. "I wish," says Michaelis, "this Concordance were in the hands of every theologian." It contains Heb. et Chald. Indices; but the book of Daniel is omitted, the Septuagint version of it being at that time unknown.

The most important concordances of the Greek New Testament are, Betuleii 'Concord. Græcæ Nov. Test.,' fol. 1546. This is the first which appeared: it is now extremely scarce. 'Concord. Græco-Latinæ Nov. Test. ab Hen. Stephano Concinnatæ,' fol. 1594, 2nd ed. 1624, is a work unworthy of so distinguished a man, on account of its great inaccuracy. Schmidii 'Nov. Test. Græci *ταμιεῖον*,' fol. 1638, revised ed. 1717 at Gotha, was beautifully reprinted in 2 vols. 8vo, at Glasgow, 1819. It is much more correct and valuable than that by Stephens. The 'Lexicon Anglo-Græco-Lat. Nov. Test.,' by Andrew Symson, fol. 1658, is a work of prodigious labour, but rendered almost useless by its bad arrangement. The 'Concordance to the Greek New Testament,' with the English to each word, by Dr. Williams, 4to, 1767, is sufficiently complete for ordinary purposes. A very valuable work is C. H. Bruder's 'Omnium Vacum Novi Testamenti Græci,' 4to, Lips. 1843. The first concordance to the Latin Vulgate is that by Cardinal Hugo, entitled, 'Concord. Bibliorum et Canonum,' fol. 1479. After the revision of the Vulgate by Pope Sixtus V., a new and amended edition of Hugo's work appeared at Antwerp in 1617, and subsequently at Geneva in 1625, and at Paris in 1683. There have since been a great number of reprints. The best is that of Avignon, 2 vols. fol. 1786. In compiling the original MS. it is said that the cardinal engaged the services of 500 Dominican monks.

The first Concordance to the English New Testament was "imprinted by Thomas Gybson" previous to the year 1540. The first to the entire Bible is by "Jhon Marbeck," London, in folio, 1550. Subsequent to these there have been several, the principal of which are, Knight's 'Concordance Axiomatical,' fol. 1610; Cotton's Concordance, fol. 1618; Newman's large and complete Concordance, fol. 1643; Bernard's 'Thesaurus Biblicus,' fol. 1644; Wilkins's Concordance, 4to. 1647; Powell's, 8vo. 1671; the 'Cambridge Concordance,' fol. 1689; Butterworth's, 8vo, 1767. But by far the most complete and valuable is the one by Alexander Cruden, the merits of which are too well known to require any remark. The first edition was in 4to, 1737; but the most correct is that of 1810. An 8vo. edition, beautifully printed, appeared in 1824. We must notice finally the 'Concordance of Parallels,' by the Rev. C. Crutwell, 4to, 1790. It is a work of great value, compiled with immense labour from a multitude of Bibles and Commentaries in the Hebrew, Latin, French, Spanish, and other languages. For further details respecting the Concordances here mentioned, and several others, see Watt's 'Bibliotheca Britannica;' Orme's 'Bibliotheca Biblica,' and Darling's 'Cyclopædia Bibliographica.'

The word has come to be used in a similar sense as applied to other works. Twiss and Ayscough each published a Concordance to Shakspere, but they have been completely superseded by the excellent one compiled by Mrs. M. Cowden Clarke in 1847.

CONCORDAT is the name given to a formal agreement between the see of Rome and any foreign government, by which the ecclesiastical discipline of the Roman Catholic clergy and the management of the churches and benefices within the territory of that government are regulated. It is, in fact, a diplomatic negotiation and treaty concerning ecclesiastical affairs, including also temporalities belonging to the Church. The frequent disputes between the popes and the various states of Europe touching the right of appointing to vacant sees and benefices [BENEFICES], and also about the claims of the see of Rome to part, or in some cases the whole, of the revenues of vacant sees and livings, and of the first fruits and tenths of those which it had filled, as well as the immunities claimed in various times and countries by the clergy and supported by Rome, such as exemption from taxation, and from the jurisdiction of the secular courts, the right of asylum for criminals in the churches, and other similar claims, the particulars of which are found in the history of every country in Europe;—all these have given occasion to concordats between the popes and particular states, in order to define the rights of each party, to draw a line between the secular and ecclesiastical jurisdictions, and thus put an end to controversy and scandal. By the concordat of 1516 between Leo X. and Francis I., the king abolished the right exercised by the chapters of electing the respective bishops, a right assured to them by St. Louis and by the states of the kingdom under Charles VII. in 1438. The parliament refused for two years to register this concordat, as contrary to the spirit of the general councils and the liberties of the Gallican Church; it registered it at last, March 19, 1518, "by express and repeated commands of the king." (Gregoire, 'Essai Historique sur les Libertés de l'Eglise Gallicane.') Concordats became most frequent from about the middle of the 18th century, an epoch from which the European governments have made themselves more independent of the ecclesiastical power, and the popes have been for the most part men of an enlightened and conciliatory spirit. Benedict XIV., by a concordat with the King of Sardinia, in 1741, gave up to the latter the right of nomination to benefices in various provinces of the Sardinian monarchy, which the see of Rome had claimed till then, as well as the temporalities of the same during a vacancy. A concordat was made between the pope and Charles, king of Naples, about the same time, by which the property of the clergy became subject to taxation, and the episcopal jurisdiction in temporal matters was greatly limited. By another concordat between Clement XIV. and the King of Sardinia, the right of asylum to criminals in the churches was much restricted, and full power was given to the respective bishops to expel and give up to the secular power those guilty of heinous offences. But the most celebrated concordat is that agreed upon between Cardinal Consalvi, in the name of Pius VII., and the first consul Bonaparte, in July, 1801. By it the head of the state had the nomination to the vacant sees, but the pope was to confer canonical institution, and the bishops had the appointment to the parishes and their respective dioceses, subject however to the approbation of the government. The clergy became subject in temporal matters to the civil power, just like laymen. All immunities, ecclesiastical courts, and jurisdictions were abolished; and even the regulations of the public worship and religious ceremonies, and the pastoral addresses of the clergy, were placed under the control of the secular authorities. Most of these provisions remain in force in France to the present day. Other concordats have been made with some of the Italian states. By that of 1818 with Naples, the king proposes the bishops, subject to the pope's scrutiny, and the pope consecrates them; the bishops have the right of censorship over the press; and the ecclesiastical courts are re-established for matters of discipline and for ecclesiastical causes as defined by the council of Trent. Appeals to Rome are allowed. It appears from the above facts, that the ecclesiastical authority and influence in Roman Catholic countries vary considerably according to the concordats, if there be any, entered into with Rome, or according to the civil regulations adopted and enforced by the respective governments towards the clergy as towards laymen. The most recent concordat is that with Austria in 1855, by which the papal power was widely extended over all the Austrian dominions, and a large amount of jurisdiction was granted to it over all institutions for purposes of education, and over works issued from the press. In Sept. 1859, however, an imperial patent relieved the Protestants, both Lutheran and Calvinistic, of Hungary, Croatia, Servia, and Transylvania, from all subjection to Roman Catholic authorities, and provided for the ecclesiastical and educational regulation of their communities by consistories of their own choosing.

CONCRETE, *concrētum*, in philology and metaphysics, is an epithet applied to the conception or expression of a quality which refers to or implies some particular subject in which the quality exists. It is used to denote a term having a naturally implied union with a subject; in other words, it signifies a quality accompanied with its particular subject, without any mental separation or abstraction, as learned, long, wise, round. It is therefore directly opposed to *abstract*, which denotes a quality conceived generally and separately, without reference to any object to which it belongs, as learning, length, wisdom, roundness. Thus the names of classes are abstract, and the names of individuals concrete; and from concrete adjectives are made abstract substantives. Concrete numbers are subject to the same explanation, being such as indicate or directly imply a subject, as two men, five shillings, in contradistinction to abstract numbers, which denote a conception of the aggregate of two or five units. Concrete terms, in the scholastic phraseology, are called *paronyma.* The following remark is from Locke's 'Essay' (b. 3, c. 8, § 1): "This distinction of names shows us the difference of our ideas; for if we observe them, we shall find that our simple ideas have all abstract as well as concrete names, the one a substantive, the other an adjective, as whiteness, white, sweetness, sweet."

CONCRETE, an artificial conglomerate used by builders, principally in foundation works, when the subsoil is of a damp, or of a compressible nature; it is usually made of lime, sand, and gravel or broken stone, and its useful action in the cases above cited consists in the perfection with which this conglomerate forms a solid, homogeneous mass—a species of monolith, in fact, able to distribute the superincumbent weight over the whole surface it covers. Sometimes concrete is used as a backing to quay or retaining walls, and then its successful application depends on the degree of hardness or solidity it may attain, and to its powers of resistance to the transmission of water. Occasionally, also, concrete is used as a walling material by ramming it into moulds, which have, as matrices, the forms the concrete itself is intended subsequently to represent in relief. According to the purposes the material is thus required to fulfil, it is necessary to adopt more or less care and skill in its fabrication; and indeed, in some cases, the differences in the style of manipulation adopted are so great as almost to render necessary the introduction of the French word *beton*, to express a mode of making concrete which is essentially unlike the one usually adopted in the greater part of England.

The habitual mode of making concrete adopted in the south-east of England, is to mix the *groundstone lime* obtained from the calcination of the chalk marl (a species of argillo-calcareous stone, in which the silicate of alumina is present in proportions varying from 8 to 14 per cent. in the best varieties) with *screened ballast*, or shingle, in the proportion of one of ground-lime to 7 or 9 of ballast, measured in bulk; and to perform the operation of slaking, or of supplying the quantity of water required for the subsequent crystallisation of the lime, simultaneously with the intermixture of the above ingredients. The lime and ballast are then, after being frequently turned over, thrown into the place they are intended to occupy, and in well-executed works they are rammed carefully into all the corners of the foundations. In those parts of England where the more decidedly argillaceous limestones are used for the purpose of obtaining lime, greater precautions are however used, and are required; for that class of materials absorbs water under such very different conditions from the gray-stone lime, that the slaking would not take place satisfactorily, if a longer time and a more intimate contact between the lime and the water, than is admissible in the case of the stone lime, were not allowed in the cases of the use of the blue lias, or of the other limes possessing similar properties to it. The precise nature of these properties will be discussed under LIME; but it is advisable here to state, that the philosophy of the action of that material is, simply, that it should form a binding or cementitious substance, which should in its turn form the *gangue* of the other materials it is intended to connect. This is effected by presenting to the caustic lime (deprived of its water of crystallisation and of its natural dose of carbonic acid by calcination) the quantity of water requisite to enable it again to resume a solid form around any given object; but it is found that the purer varieties of lime do not solidify with sufficient rapidity, or in a sufficiently permanent manner, to allow of their being used in building operations; whilst the varieties which contain certain proportions of clay (silicate of alumina) yield limes which are able to set with rapidity, and even to resist the action of water after a short time. It is on account of this power of resisting the action of water, that some limes are called *hydraulic*, and the others which do not possess it are called *non-hydraulic;* but the hydraulic limes also have these characteristic differences from the non-hydraulic ones, namely, that they absorb the dose of water requisite for their crystallisation very slowly; that they do not sensibly evolve much heat in fixing the water; and that they do not increase much in volume: whereas the non-hydraulic limes absorb water rapidly, and begin at once to decrepitate with a marked increase of volume, and a copious evolution of heat and vapour.

Now, the differences to be observed in the modes of making concrete depend on these respective properties of limes. When the moderately hydraulic limes are used, the operation of slaking takes place so rapidly, that it may often be desirable to hurry the operations connected with its mixture with the materials it is intended to unite; and at any rate there seems to be little danger of a subsequent slaking, when *ground* stone lime is used, and a fair quantity of water is at once presented to it. But in the use of hydraulic limes, this careless mode of treatment would be fatal to the successful result, for with them it is essential that every particle of the lime should take up its dose of water, and that the whole of the mechanical changes in the lime should be completed before the conglomerate itself is placed in its definitive position. It follows, therefore—and herein practice and theory agree—that the more decidedly hydraulic a lime is, the more perfectly must the operation of hydration be performed; and consequently, in all cases where the hydraulic limes are used, it is customary to mix them with the quantity of sand which would be used to make ordinary mortar, under edge-rollers, and then to mix the mortar so prepared with the screened ballast. This process is, in fact, neither more nor less than the execution of rubble masonry with very small materials; and the resulting material is the one to which it appears to be desirable to apply the term *beton*, by way of contradistinction to the more imperfect and less valuable substance called ordinarily *concrete.* The proportions of lime, sand, and ballast to be used in the formation of beton must depend on the quality of the lime; it being always understood, that the more hydraulic a lime is the less sand will it carry, but that, at the same time, this very same quality renders its use more advisable for foundations to be executed in water, or in damp situations.

A very objectionable practice is sometimes adopted by the London builders, when they use concrete in damp situations, of mixing ground stone lime and ballast without slaking the lime at all, and of leaving it to absorb the requisite quantity of water from the ground, or other position in which the concrete is to be placed. Now, in such cases the slaking must take place irregularly and unequally, and the changes of volume thus produced must tend to disintegrate the mass. In fact, whatever be the description of lime used, it is essential that the hydration should be completed before the concrete or beton is put in place.

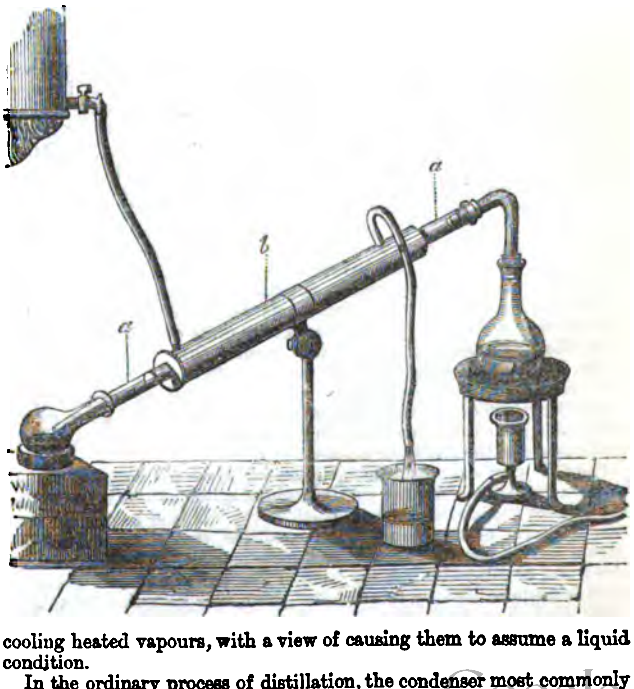
CONCUBINAGE is the cohabitation of a man with a woman, to whom he is not united by marriage. Among the Romans, concubinage was in use before the time of the Emperor Augustus, yet without being formally permitted by law. Augustus, with the view of preventing celibacy and encouraging marriage, A.D. 10, caused the famous law called Lex Julia and Papia Poppæa to be passed, which may be considered as much an ordinance of moral police as a measure in favour of population. This law contained several conditions advantageous for those who had the greatest number of children. By the same law, concubinage was legally allowed to unmarried men, with the restriction that not more than one concubine could be taken, and she must be a woman with whom marriage was not permitted, as women of mean descent, freedwomen, &c. The concubine did not enjoy the same rights as a wife, and the children begotten in concubinage were not considered as legitimate, but were called natural (naturales), a distinction which was of importance as to the right of succession.

Concubinage being inconsistent with the principles of Christianity, the Emperor Constantine the Great enacted laws against the institution, and it is now in all Christian countries considered unlawful. Yet in Germany, among the reigning families, a left-handed or morganatic marriage (Trauung an die linke hand or morganatische ehe) still sometimes occurs. This kind of marriage resembles the Roman concubinage, as well in its conditions as its consequences.

CONCUSSION OF THE BRAIN, SPINE, &c. [HEAD, INJURIES OF THE.]

CONDENSATION. [EXPANSION.]

CONDENSER is the name given to any piece of apparatus used for cooling heated vapours, with a view of causing them to assume a liquid condition.



In the ordinary process of distillation, the condenser most commonly employed is the *worm-tub.* This consists of a metal pipe usually twisted into a spiral form, for the sake of compactness, and so fixed in a tub that a few inches of one end of the pipe may pass through, and accurately fit, a hole bored near the bottom of the tub. By this means the metal coil can be kept constantly surrounded with cold water, so that vapours coming from a boiler or other distillatory apparatus are effectually condensed. The upper portions of the *refrigeratory*, as this apparatus is sometimes called, will necessarily become heated first, and as hot water is lighter than cold, an arrangement should be made whereby a stream of cold water can enter at the bottom of the tub and the hot water pass off near the top.

Liebig's condenser is the form most frequently employed in chemical laboratories, and for experimental purposes generally. Its construction, and the method of using it, are seen in the annexed figure.

The glass tube, *a a*, through which the vapours pass, is usually about three-fourths of an inch in diameter, and is surrounded by another tube, *b*, commonly made of tin-plate or zinc, about two inches in diameter, and having at each extremity a neck through which the tube *a* passes. The ends of the necks of the external tube, and a small portion of the glass tube near them, are connected together by means of a strip of sheet caoutchouc carefully bound round. An aperture near the lower part of the external tube admits a current of cold water, and a similar aperture near the top allows the heated water to flow off. The inner tube is thus constantly surrounded with cold water, and heated vapours passing through it are perfectly cooled and condensed.

CONDENSER OF ELECTRICITY. [ELECTRICITY.]

CONDIMENTS. [AROMATICS.]

CONDITION. Two possible events, A and B, may be so related, that (1) when A becomes event or effect, B also shall become event or effect: (2) or so that B being already event or effect, when A becomes event or effect, B may either cease to be event or effect, or may be diminished as to event or effect, or enlarged as to event or effect. This kind of relationship may be expressed by the term, condition, and the words by which this condition is made, may be any that are free from ambiguity. In case (1) where A must happen before B can, this may be called a condition precedent. In case (2) where B, already being event or effect, is extinguished or modified by the subsequent event A, this may be called a condition subsequent. The events may be more than two, and the condition which expresses their relation may be more or less complicated, but the general nature of the relation will still subsist. The application of this principle to legal questions is simply this: Conditions precedent are conditions annexed to any gift of an estate or interest which at law must be strictly performed, before such estate or interest can vest in the person designated by the gift. Conditions subsequent are when the estate or interest is already vested, but its continuance in the person in whom it is vested depends on the breach or performance of the conditions.

Cases may arise, and in construction of agreements and particularly of wills often do arise, in which it is not easy to say whether the condition is precedent or subsequent; but in general, the difficulty arises rather from certain technical rules of law applicable to the construction of instruments, than from the bare terms in which conditions are expressed.

Littleton's description of an estate upon condition is this: (325) "Estates which men have in lands or tenements upon condition, are of two sorts, viz., either they have estate upon condition in deed, or upon condition in law, &c. Upon condition in deed is, as if a man by deed indented, enfeoffes another in fee simple, reserving to him and his heires yearely a certaine rent payable at one feast, or divers feasts per annum, on condition that if the rent be behind, &c., that it shall be lawful for the feoffor and his heires into the same lands or tenements to enter, &c. And if it happen the rent to be behind by a week after any day of payment of it, or by a moneth after any day of payment of it, or by half a yeare, &c., that then it shall be lawful to the feoffor and his heires to enter, &c. In these cases, if the rent be not paid at such time, or before such time limited and specified within the condition comprised in the indenture, then may the feoffor and his heires enter into such lands and tenements, and them in his former estate have and hold, and the feoffee quite ouste thereof. And it is called an estate upon condition, because that the estate of the feoffee is defeasible if the condition be not performed," &c.

An estate thus given is liable to be defeated, that is, the gift upon non-performance of the condition may be resumed by the giver, or his heirs: this is a condition subsequent, that is, subsequent to the vesting of the estate in the feoffee or grantee.

The following example from Littleton will show the difficulty which has been introduced into the construction of conditions by the peculiar character of the laws of England (Litt. 350): "If land be granted to a man for term of five yeares, upon condition, that if he pay to the grantor within the two first yeares, forty markes, that then he shall have a fee, or otherwise but for term of the five yeares, and livery of seisin is made to him by force of the grant, now he hath a fee-simple conditionall, &c. And if in this case the grantee do not pay to the grantor the fortie markes within the first two yeares, then immediately after the first two yeares past, the fee and the freehold is and shall be adjudged in the grantor, because that the grantor cannot after the said two yeares presently enter upon the grauntee, for that the grauntee hath yet title by three yeares to have and occupie the land by force of the same grant. And so because that the condition of the part of the grantee is broken, and the grantor cannot enter, the law will put the fee and the freehold in the grantor."

On this Coke remarks, that many are of a different opinion from Littleton, because the fee simple is to commence upon a condition precedent (of which class the condition in the case put by Littleton clearly is), and yet "here Littleton, of a condition precedent doth (before the performance thereof) make it subsequent." And yet Littleton is right, for the legal effect of the livery of seisin is to pass a present state of freehold.

It is a rule of law that none but the grantor and his heirs can have the benefit of a condition; and that any conditions are good which are not unlawful, impossible, immoral, or absolutely inconsistent with the nature of the estate given. An instance of the last kind of condition (Littleton, 360) would be a feoffment, or a devise in fee, upon condition that the feoffee or devisee should not alien the land to any person; such a condition, being inconsistent with the estate given, is void.

Before the Statute of Westminster 2, *De Donis Conditionalibus*, if lands were given to a man and the heirs of his body, as soon as he had issue of his body, this fee-simple conditional became for some purposes, and among them, for alienation, an absolute fee-simple. The effect of this statute was to convert conditional fee-simples into estates tail. [TAIL, ESTATES.]

Conditions in English law were of feudal origin. The rents and services of the feudatory were considered as conditions essentially annexed to his fief, and were called conditions in law, or implied conditions. The neglect of these conditions was a forfeiture of the fief to the lord of whom the tenant held his lands. Expressed conditions, or conditions in deed, were subsequently introduced, but as we have already shown, they savoured of their origin in this, that the donor's remedy for breach of conditions was limited to him and his heirs. But the doctrine of conditions has long ago been extended to all such cases as the complicated relations of a rich and populous country require, and, as in the Roman law, so now in the law of England, conditions may form a part of every written instrument by which men regulate their mutual dealings, or dispose of their property. These conditions, and the construction of them, vary with the nature of the instrument of which they form a part; and the construction of such conditions is further subject to some variations, owing to the different aspects under which they are regarded by courts of law and equity.

Those conditions which are of most practical importance, are the conditions of BONDS, LEASES, MORTGAGES, and WILLS. The last head includes conditions annexed to portions and LEGACIES, which have given rise to a great number of disputes, and to numerous and not always consistent judicial decisions.

As to conditional limitations of real property, and the difference between them and remainders and conditions (this being a matter purely technical), the reader is referred to Fearne's 'Essay on Contingent Remainders;' and Butler's note on Co. Litt., note 94.

CONDITION OF A BOND. [BOND.]

CONDITION (Mathematics) is used in nearly the same sense as in common life. Thus the proposition, to describe an equilateral triangle upon a given straight line, is not to describe *any* triangle, but a triangle under the following *conditions*; that it must be equilateral, and that it must have a given line for its base.

An *equation of condition* means an equation which will not always be true, but requires certain conditions to be satisfied; and is distinguished from an *identical equation*, or one which is true independently of all conditions. Thus, $x+x=2x$ and $(a+x)(a-x)=a^2-x^2$ are identical equations: they are true for all values of x and a. But $x+2=3$, and $4x-x^2=3$ are equations of condition: the first cannot be true unless $x=1$, nor the second unless $x=1$, or $x=3$.

But the term *equation of condition* has a more technical meaning in the application of mathematics to the sciences of observation. Suppose, for example, that x, y, and z are certain quantities to be found, but which cannot be observed directly: they are, however, connected with each other by an equation, say $ax+by+cz=h$, where, a, b, c, and h are different at different times, or for different circumstances of observation, but still are so connected that the preceding equation must be true; and where a, b, c, and h can either be observed, or computed from observations. Let a_1, b_1, c_1, and h_1 be the results of a first observation; a_2, b_2, &c., of a second; then for n different observations, we have the n following equations:—

$$a_1x+b_1y+c_1z=h_1$$
$$a_2x+b_2y+c_2z=h_2, \text{ \&c.}$$

If the observations be all correct, any three of these will give the same values of x, y, and z; but if, as must happen, there be errors in every observation, the results of each triad will differ slightly from those of the rest. For the method of solving the whole set, so as to produce the most probable result, see LEAST SQUARES, METHOD OF. This is what is called the formation of *equations of condition*.

CONDOTTIE'RI, a word in the Italian language signifying captains, chiefs, or leaders, but most usually employed to designate soldiers of fortune, who raised corps of cavalry and infantry at their own expense and engaged with princes and governments for their services as mercenaries. The practice of employing these mercenaries, which commenced in the early part of the 14th century, originated in the Italian princes and republics commuting the personal services of their subjects in war for pecuniary payments, with which they were enabled to hire mercenaries. As early as 1225, Genoa took the Count of Savoy into pay with 200 horse. Florence retained 500 French lancers in 1282. After the expedition of the Emperor Henry VII. in 1310, many soldiers of fortune remained in the service of Milan, Florence, and other states. Pisa appears, in 1343, to have disbanded a corps of German mercenaries, whose leader, Guarnieri, refusing to lay down his arms, levied contributions throughout the Italian states. In 1353, a band under the command of Fra Moriale, afterwards of Conrad Lando, called the Great Company, appeared in Italy, and extorted money from many of the Italian states. During the long and bloody wars between our Edward III. and France, foreigners from different parts of Europe, attracted by his fame and liberality, and allured by the hope of plunder, flocked to his standard. They were for the most part men of desperate fortunes, or unable to live at home according to their wishes. At the conclusion of the treaty of Bretigni in 1364, which restored peace to England and France, these soldiers, unable to relinquish a course of life to which they were accustomed, and being without other means of subsistence, were dispersed into the several provinces of France, where they possessed themselves of castles and fortresses, and associating themselves with the banditti of their vicinities, levied contributions on all within their power, and under the names of *companies* or *companions* * they became the terror of the peaceable inhabitants of the country. These ruffians formed altogether a body of 40,000 men, and were headed in many instances by some of the most experienced leaders of the time. They fought pitched battles with the troops of France, in which they gained victories. The misery which they occasioned only served to increase their numbers; for poverty and despair drove their victims to their standard. Even their excommunication by the pope produced no abatement in their ferocity and rapine. At length the war between Henry de Transtamare and Peter the Cruel for the succession to the crown of Castile furnished an opportunity to rid France of this scourge. De Guesclin proposed to Charles V., king of France, to enlist these companies into his service and lead them into Castile. They accordingly engaged in this expedition, and in their way forced the pope, then residing at Avignon, to give them a sum of money.

From this time war became a trade in many parts of Europe, particularly in the Italian states, in which needy and desperate adventurers raised forces either by their pecuniary means or by their personal influence and reputation for conduct and courage, and engaged them for hire without the least consideration for the real or supposed justice of the cause in which they embarked. These forces were recruited from the refuse or the vagabonds of every state in Europe. The idle and profligate found in joining their bands a way of life which flattered their indolence and gratified their rapacity. The mode adopted for assembling them was by contracts with nobles who had authority over the loose and disorderly inhabitants of their estates, with captains whose address or bravery could allure adventurers to their banners, or with individuals whose poverty or choice made them offer themselves to princes or governments. In their discipline, though it was far from exact, and in courage and conduct in war, they were superior to the troops which could be then raised under the powers of the feudal system. Besides the profit which they gained on the ransom of their prisoners, their pay, according to the then value of money, appears to have been high (assuming them to have been as well paid as the other troops), and that of the private soldiers to have been at a much higher rate in proportion to the commanders and officers than in modern times. At the siege of Calais, in 1346, Edward, prince of Wales, for himself and retinue, for his wages of war, had 20*s.* a day. The pay of Henry, earl of Lancaster, for his "wages of war," was 6*s.* 8*d.* a day; 11 bannerets, 4*s.* a day; 193 knights, 2*s.*; 512 esquires, 1*s.*; 46 men-at-arms and 612 archers on horseback, each 6*d.* a day. From the known rapacity of these mercenaries, it is not likely that they would have accepted lower terms than the other troops engaged in the same enterprise. According to Villani, they frequently demanded and received double pay, with a premium or bounty-money of a month's pay, on their engagements. But their chief inducement to serve was the plunder of the towns or castles which they took, the contributions they levied, and the ransom of the prisoners. From this motive they were induced not only to spare their own men as much as possible, but to give quarter to their enemies. This rendered some of their battles nearly bloodless, a ludicrous instance of which occurred in one of the Italian wars. Piccinino advanced to attack Florence with an army of several thousand men. The place was defended by Capponi with another body, principally composed of mercenaries. The two armies engaged at Anghiari, a short distance from Florence. The battle lasted four hours. Piccinino was totally defeated, and fled to Borgo San Sepolcro with about a thousand men. The rest were made prisoners; only one man was killed, and this owing to the accident of his falling from his horse and being trodden under foot. Capponi, however, was unable to follow up his success, and his troops refused to advance till they had secured their plunder. Several other battles, equally bloodless, were fought in the wars of this period.

The Condottieri were notorious for bad faith in their engagements with the states they served. Their rapacity was equal to their bad faith; besides their pay, they exacted gratifications for every success. Such was the terror they inspired, that some of the Italian states paid them large sums not to pass through their territories. With the improvement of artillery and the introduction of musquetry the condottieri declined; but it is difficult to state the period of their extinction. Our countryman, Sir John Hawkwood, is said to have been the last, as he was beyond comparison the most eminent for his skill in military affairs. Sir John died at Florence in 1393 at an advanced age, and was buried with great pomp by the Florentines. There is a cenotaph to his memory in the church of Sible Hedingham, Essex, where he was born.

(Froissart; Villani; Machiavelli; Aretin.)

CONDUCTOR OF HEAT. [ELECTRICITY; HEAT.]

CONDUIT, the artificial channel in which water is conducted from the point of supply to the place of delivery or of outfall. It may be either circular or polygonal in section, open or closed, of earth, masonry, or metal, and in each particular case the formation of conduits gives rise to the application of special laws of construction and of calculation. For the purposes of discussion, it would be more convenient to consider the various questions connected with the flow of water in channels of a circular section under the head of WATER PIPES, even when it may not run in them "full bore;" and at present it is therefore proposed to treat solely of channels or conduits with polygonal sections, such as are usually employed in canals, cuts, mill-races, &c.

Practically (that is to say, with reference to the mode of *building* the channels, and assuming that word to apply to the use of all kinds of constructive materials) the system of constructing a channel must be regulated, firstly, by the purposes for which the water it is intended to conduct is subsequently to be applied; and secondly, by local circumstances connected with the choice of materials or the economy of execution. For the purposes of navigation, open channels of a trapezoidal form in earthwork are sufficient, provided the requisite degree of impermeability in the bed be secured; and even for a water supply such channels may be admitted, if the water should flow in the open air of the country, where it would not be exposed to take up atmospheric impurities. But if the earth of which the banks are made should be liable to be removed, or if it be essential to reduce the sectional area of the water-way to the minimum, as when a canal has to be carried upon an aqueduct; or if it be necessary to protect the water from contamination by soot or dust, then the channel must be made of masonry, and, as a general rule, of a rectangular form, though for certain theoretical reasons the portion of the section normally filled would be more satisfactorily made in the shape of a regular half hexagon, whose complete diameter should be the water-line, and be equal to twice the depth.

In earthen channels it is essential to observe that the *bottom* velocity must never exceed that which would be required to remove the materials of which the bed is formed. A certain velocity is at all times necessary in the stream, in order to prevent the growth of the peculiar vegetation which usually grows in earthen channels; but if the velocity should exceed the rates indicated in the following table, the permanence of the channel may be dangerously affected. It is usually considered that the minimum velocity to be given to the waters of any artificial open conduit should be from 10 to 14 inches per second, or from 50 to 60 feet per minute, in order to avoid the dangers of interference with the discharge from the above-named cause; namely, the growth of plants. It is usually considered, however, that the bottom velocities should not exceed the rates of

25	feet per minute	in	soft alluvial beds.
40	„	„	soft clayey beds.
60	„	„	sandy and silty beds.
120	„	„	gravelly beds.
180	„	„	strong gravelly beds.
240	„	„	shingly beds.
300	„	„	shingly and rocky beds.
400	„	„	rocky beds, or in smooth masonry.

In open masonry conduits, wherein the water flows without pressure, the transverse section must depend upon the uses to which the stream is to be devoted; because the draught of canal boats may, for instance, render it necessary to modify the ordinary relations of width and depth; or, in an aqueduct, the effects of ordinary frosts may render it advisable to increase the theoretical depth. In closed conduits the choice of the transverse section will be influenced by the considerations arising from the quality of the waters, and from the precautions necessary to maintain in it a constant flow. As it is usually possible to regulate the admission of the water, it would seem that the form which would most commonly be adopted would be the semicircle, because in a channel of that form the wetted border would be the least in proportion to the volume discharged. But it is found that it is easier to execute a long artificial channel with the requisite degree of regularity of outline and of fall, when its section is made nearly rectangular in the immediate channel; and it is on this account that the Croton and the Roquefavour aqueducts were made of the precise sections adopted in their respective cases.

---

* They were sometimes called cotelli, probably a corruption of coltelli, from their bearing knives, or large daggers.

Notwithstanding the improvements which have lately taken place in the application of science to the purposes of building, it is not possible to suggest any material improvement upon the system adopted by the Roman engineers in the construction of their covered conduits for town supplies. They kept the extrados of the covering of the vault at least two feet below the ground, or they covered the vault with earth of the same thickness when the conduit was raised above the surface; men holes were, however, left for the purpose of examination and repair, and from distance to distance chimnies for ventilation were introduced. Great pains were taken to ensure the impermeability and the solidity of the sides and bottom of the conduit, and the deposit of any accidental impurities the waters might contain. The Croton aqueduct was almost a literal copy of the old Roman works of the same description; and if we except the construction of some very unnecessary bridges, instead of using the modern system of cast-iron reversed syphons, in passing some of the deep valleys, the whole of this work may be referred to with satisfaction. It may be added, that the Croton aqueduct is covered throughout its whole length, a precaution which ought almost always to be adopted in executing the conduits of town supplies.

The dimensions to be given to a channel for conveying water, merely by the velocity due to the fall of its entire length, are ascertained on the principles that the mean velocity is to the maximum velocity in the centre of the stream as 0·81 to 1·00, in the case of small channels, and as 0·835 to 1·00 in larger ones. Then as the area of the stream must be equal to the volume divided by the velocity, or as $S = \frac{Q}{v}$, provided the mean velocity be known, the area of the transverse section required to deliver a certain quantity of water may easily be ascertained. It generally happens that the width of a conduit is fixed by the peculiar circumstances of the case, as, for instance, in a mill-race, it will be affected by the width of the stream allowed to fall over the shuttle; in a canal, by the beam of the barges; and in a water supply, by the necessity for examination and repairs. As the best depth is that equal to twice the width, to some extent the only unknown element in the above equation is the velocity; and inasmuch as some of the conditions which limit the minimum velocity have been already stated, it may be as well here to add, that for a town water supply it is considered that it is desirable, in order to maintain a proper aeration of the waters, to secure a velocity of from 2 feet 8 inches to 3 feet per second.

In fact, it thus appears that the whole of the conditions, as to the section and fall of a channel, may be ascertained by the mean velocity of the water flowing in it, and that the formula given by Mr. Beardmore for calculating that velocity will, by transposition, furnish the elements of the other unknown quantities. His formula may be expressed thus: calling h the hydraulic mean depth in feet; i, the inclination of the channel, in feet per mile; and v, the velocity of the stream, in feet per minute; then $v = 55\sqrt{h.2i}$. Of course this quantity multiplied by the sectional area in feet gives the discharge in cubic feet per minute. The hydraulic mean depth, it may be added, is obtained by dividing the sectional area of the channel by the wet border. [HYDRODYNAMICS.]

CONE (Mathematics). In the most general sense, a cone is a surface formed by the motion of a straight line indefinitely extended in both directions, and which always passes through one given point (called the vertex). Any curve in space may be a guiding line (or directrix) through which the moving straight line may be made to pass.

But in common language the term cone is only applied to those general cones in which the directrix is a circle. Of these there are two kinds: the *oblique* cone, when the vertex is not in the axis of the directing circle (the axis being the perpendicular drawn to the plane of the circle through its centre); the *right* cone, in which the vertex is in the axis. The most prominent distinction between these two kinds of cones is this: that the oblique cone has two distinct sets of circular sections, whose planes are not parallel to each other [SUBCONTRARY], while the right cone has only one set of circular sections, all parallel to the directing circle.

The right cone is an infinitely extended surface, or consists of two cones (according to the most common notion) joined together by the vertex: but out of mathematics a portion of such cone is called a cone contained between the vertex and the directing circle, then called the *base*. In the rest of this article we shall use this meaning of the word.

The surface of a cone (in the common sense) is one half the circumference of its base multiplied by the distance from the vertex to the circumference of the base (called the *slant side*). Thus the diameter of the base being 10 inches, or the circumference 31·416 inches, and the slant side being 20 inches, the surface of the cone is $\frac{1}{2} \times 20 \times 31·416$, or 314·16 square inches. The cone unrolled gives a sector of a circle, the angle of which, in theoretical units [ANGLE], is the circumference of the base divided by the slant side. Thus in the preceding instance 31·416 ÷ 20 or 1·5708 is the angle of the unrolled cone, which is a right angle.

The solidity of a cone is one third of the product of the area of the base and the perpendicular distance of the vertex from the axis. In the preceding instance the perpendicular aforesaid is

$$\sqrt{(\text{slant side}^2 - (\text{rad. of base})^2}, \text{ or } \sqrt{400-25}.$$

or $\sqrt{375}$, or 19·3649 inches. The area of the base is 3·1416 × 25, or 78·54 square inches: and this multiplied by one third of 19·3649, or 6·455, is 506·976, the number of cubic inches in the cone. The centre of gravity of a cone is in the axis, at a distance from the centre of the base equal to one-fourth the distance of the vertex.

CONFARREATION. [MARRIAGE.]

CONFECTIONS; CONFECTIONARY. Confections, called also *Conserves*, are formed of fresh, generally succulent, vegetable substances, in a few instances with prepared chalk, as in the aromatic confection, preserved by means of sugar or honey. These confections were formerly much more numerous, and were examples of the polypharmacy prevalent among our ancestors: the number might be still beneficially reduced. The quantity of sugar required to prevent them from spoiling is so great as to disagree with delicate stomachs. In several instances the ingredients are ordered to be kept apart, or if associated in a dry state, the water or syrup is to be added when the preparation is intended to be used; as in the case of the aromatic, opiate, and almond confection. This is especially necessary in regard to the last; for if bitter almonds should be accidentally introduced, the presence of water might produce deleterious combinations.

When astringent substances such as roses are to be pounded, this process must be conducted in marble, not iron, mortars. The quantity of sugar is better to be excessive than deficient; and more is required in wet seasons than in dry. The conserves should be put into several small pots, rather than one large pot, which should be glazed with salt, as in Bristol ware, not lead. They should then be well closed, and kept in a dry cool place. Patent jars, of a very useful kind, are now manufactured for this purpose.

The chief confections are those of acorns, alkermes, almonds, bark, cassia, catechu, copaiba, hemlock, hops, ipecacuanha, jalap, succory, nitre, opium, orange flowers and peel, pepper, peppermint, resin, rose, rue, scammony, senna, &c.

Confections are generally medicinal; but *confectionary* mostly comprises sweetmeats having no relation to the medical art. The making of this confectionary may be regarded as one of the domestic arts, practised by highly paid persons in the mansions of the nobility and other wealthy families; but it is as a distinct trade that we here view it.

Sugar is the basis of all confectionary; and the processes of boiling, clarifying, candying, crystallising, refining, bleaching, and otherwise treating this important substance, must be well understood by a confectioner. The boiling is carrried to nine or ten different degrees or stages, technically known by the curious names of the "small thread," the "large thread," the "little pearl," the "large pearl," the "blow," the "feather," the "ball," the "crack," the "caramel," &c.; each stage is applicable to a particular purpose in confectionary; some for syrup, some for candy, &c. These processes are only an exemplification, on a small and delicate scale, of those which the reader will find described under SUGAR. The *syrups* form an important section of the confectioner's art. They are either the juices of flowers, or a decoction or infusion of the leaves, flowers, or roots of vegetables, impregnated with a sufficient quantity of sugar for their preservation in a liquid state. Many of these are made only for medicinal purposes; but others belong properly to confectionary, and comprise the agreeable qualities of raspberry, currant, cherry, mulberry, lemon, gooseberry, orange, liquorice, violet, pink, rose, marshmallow, coltsfoot, ginger, almond, pistachio, or other vegetable substance. Instead of syrups, a change in the mode of procedure will produce *candies*, in which the vegetable juice, decoction, or infusion is crystallised or granulated into a hard substance. A third mode of treatment produces *cracks*, so named from eating short and crisp, and including barley-sugar, sugar drops, kisses, acid drops and sticks, brandy balls, rock, hardbake, &c. Another variety comprises *lozenges*; these consist of loaf sugar in fine powder, mixed with various substances, made into a paste with dissolved gum, rolled out into thin sheets, and formed by means of tin cutting-tools into small oval, square, round, or other shaped pieces. The substance chosen to mix with the sugar is the juice or some other extract of peppermint, rose, cinnamon, clove, lavender, ginger, nutmeg, rhubarb, tolu, saffron, marshmallow, vanilla, catechu, &c. *Pastile drops* are compounds of refined sugar with some kind of aromatic spirit, made into flat drops. *Comfits* mostly consist of seeds, such as those of the caraway, coriander, celery, or cardamom, enveloped in sugar; but sometimes the inner substances thus treated are fragments of cinnamon, almonds, barberries, preserved cherries, orange or lemon peel. Another department of the confectioner's art is that of making *jellies*; these are the juices of mucilaginous fruits, combined with sugar, rendered clear by filtering through a flannel bag, and boiled to the well-known jelly-like consistency; they are made from a large number of different fruits. *Marmalades* and *jams* are preserves of orange, lemon, apple, pear, quince, plum, or other fruit; the pulp of the fruit is boiled with sugar to the required thickness. *Pastes* are a similar kind of marmalade or jam, but with an additional quantity of sugar, which permits of the substance being crystallised or candied into rings, knots,

&c.; these are much more numerous in kind than marmalades or jams.

Besides the compounds mentioned in the last paragraph, there are many others to which the attention of the confectioner is directed. *Preserved fruits* consist of the scarcely ripe fruit, boiled with sugar until the pulp has become thoroughly saturated with the saccharine agent; apricots, peaches, nectarines, figs, greengages, damsons, gooseberries, melons, lemons, oranges, pine-apples, cherries, grapes, currants, barberries, raspberries, pears, quinces, &c., as well as cucumbers, gherkins, orange or lemon peel, angelica, eringo, and ginger, may be thus treated. *Compôtes* bear some resemblance to the preserved fruits just noticed. *Brandy fruits* are fruits in which brandy as well as sugar is employed as a preserver. *Bottled fruits* are preserved in wide-mouthed bottles, and have undergone a careful process, by which air and moisture have as much as possible been removed from them. *Fruit waters*, for beverage, such as lemonade, raspberry-water, &c., in most cases consist of the juice of the fruit, treated with water, syrup, and lemon-juice. *Ices* are sweetened compounds which have been exposed to the action of a freezing mixture; they are made from a large variety of fruits and vegetable substances, and are classed into *ice-creams* and *ice-waters*, according to their consistence—some few being *ice-custards*. A good deal of apparatus, and much practical skill, are required for making ices. *Essences*—such as those of lemon, orange, bergamot, allspice, clove, vanilla, &c.—consist of the volatile or essential oils of fruits and other vegetable substances, extracted by means of spirits of wine, with or without distillation. A skilful confectioner possesses a wide range of knowledge in the treatment of liquids. He can distil or obtain *spirit* from various vegetable substances; he can extract the *essential oils*; he can prepare *distilled waters*, such as rose-water, cinnamon-water, &c.; he can make the numerous *liqueurs*, such as maraschino, kirchwasser, curaçoa, &c., by a peculiar application of spirit of wine to vegetable substances; or *ratafias*, which differ from liqueurs chiefly in being filtered and sweetened instead of distilled.

A peculiar part of the confectioner's trade is that which appeals to the eye, not to the sense of taste. He has to prepare table-ornaments, that may present much grace and beauty though cheap in the materials. He must know how to make gum-paste for ornaments; to prepare a paste that will bear to receive gold or colours on its surface; to form papier-mâché into rocks for a pièce montée, or into vases, &c.; to design complicated table ornaments, in which some knowledge of architecture and of sculpture may come to his aid; to lay his plans so that the parts of his temples, &c., *not* intended to be eaten may be made of cork, papier mâché, flock, paper, or gum paste, while the rest may comprise any of the sweetmeats which it is his trade to produce. The confectioner must also know how to prepare colours, and to combine them with his confections in proper kind and degree.

When the confectioner makes cakes and other articles in which flour is used, and which require the process of baking in an oven, he does so as a pastrycook, not as a confectioner.

The cheap confectionary now so largely sold in England has long been suspected of being adulterated; the price at which it is sold not being sufficient to pay for an honest course of dealing. Plaster and other substances are often used with the sugar; and poisonous dyestuffs or pigments are used as colouring agents. Cases have been reported by medical practitioners, of children being poisoned by eating such sweetmeats. Towards the close of the year 1858, about twenty persons died, and two hundred were more or less injured, in and near Bradford, in Yorkshire, by eating sweetmeats; the maker thought he was using "daff," an adulterating preparation of plaster of Paris, as a cheap substitute for sugar; instead of which, through a mistake at a druggist's shop, he was using white arsenic.

An ingenious machine for making lozenges has lately been introduced by Messrs. Chase of Birmingham. A ball of prepared sugar, flavoured with the vegetable ingredient which may be selected, is worked up to the consistence of soft dough, and rolled on a board to the thickness of ordinary pie-crust. It is then laid upon a band, which carries it between a pair of rollers, after which it is flattened and passed through other rollers, until reduced to the thickness of a lozenge. The thin layer goes again upon the band, and is by it conveyed underneath a row of stamps. These stamps bear a motto, name, or other device, as may be chosen. The layer is then punched out by circular or other shaped cutters, which throw off clean glossy lozenges. The machine can produce three hundred pounds weight of lozenges in an hour.

CONFESSION means a solemn acknowledgment of some principle or fact. Hence the early Christians, who suffered imprisonment and other penalties from the Roman magistrates for having publicly declared their belief in the gospel, were called confessors. Others, in later times, acquired the same title from having embraced a life of austerity, or retired to some solitude or convent to do penance for their sins. Confession thus became synonymous with penitence, in which sense both words are understood by the Roman Catholics. The practice of confessing one's sins, either in public before the congregation of the faithful, or privately to a priest, dates undoubtedly from the earliest ages of the Church. In those times the Christians, scattered about the Roman world, and exposed to persecution, formed many small communities, living under the discipline of their presbyters, who knew every individual of their respective flocks, the members of which watched carefully over each other's conduct. Any gross irregularity, or any compliance with heathen rites by one of the flock, was sure to be known to the rest, and the offender was thereby subject to interdiction from Christian worship and communion. If he wished to be re-admitted to the communion of the Church, he must publicly acknowledge and repent of his guilt, and submit to the penance imposed by the presbyter. This appears to have been the original mode of confession. It does not seem to be clearly determined when the practice of private, or "auricular," was substituted for public, confession. Cyprian, who lived towards the middle of the third century ('Epist.,' Rom. 12), defines several kinds of sins for which penance ought to be done before the transgressor could be admitted to the communion; and in his treatise, 'De Lapsis in Persecutionibus,' he exhorts those who have fallen into heathen practices to confess their sins to the ministers of God, and thus unburthen their souls of their weight, "because this satisfaction and the remission by the priest are acceptable to God." Tertullian, who lived at the beginning of the same century, says ('De Pœnitentiâ,' ch. ix.) that penitence consists of three parts, confession, contrition, and satisfaction. In the eastern churches the custom of confessing sins before the assembled congregation was prevalent down to the fourth century; but the practice having led to scandal, especially on the occasion of a lady revealing that she had been seduced by a deacon, Nacterius, patriarch of Constantinople, abolished the custom, and removed the pœnitentiarius or priest ('qui præpositus erat pœnitentiæ') by whose advice the revelation had taken place. (Sozomen, 'Histor.,' lib. vii.) Some passages in Chrysostom have been urged against the obligatory practice of confession. In Homily 11, he says, "God commands that to him alone we should give account of our conduct, and to him we should confess;" which agrees with the principle and practice of the Protestant and reformed churches. Yet in his Homily of the Samaritan woman, he says, "He who blushes now to reveal his sins to a man, and will not confess, at the last day will be arraigned, not before one or two persons, but before the whole world.' In the fifth century, Pope St. Leo I., called the Great ('Epist.' Rom. lxxx., ch. v.), says that the priests ought not to enforce "public confession of secret sins," but that it is enough if the penitent confess them privately to a priest. This passage seems to throw some light on the transition from public to private confession. When, and under what circumstances, confession, either public or private, was deemed absolutely necessary for the remission of sins, is another subject of controversy. Innocent III., in the fourth Lateran council, A.D. 1215 (Canon 21), made confession (meaning auricular or private) obligatory upon every adult person once a year, and that continues to be one of the rules of the Roman Catholic church to the present day, which numbers penitence among the sacraments. The Council of Trent, in its catechism, defines it to be "a declaration by the penitent of his sins, made to a priest, in order to receive the penance and absolution." Penitence, therefore, consists of four parts, confession, contrition, absolution, and penance; and it is a positive doctrine of the same Church, that without the concurrence of all these parts or conditions, the sacrament is null and void. The penitent is also obliged to confess all the sins that he can recollect having committed and not confessed before, at least all the mortal sins, for Roman Catholic dogmatists draw a distinction between mortal and venial sins. By contrition it is meant that the penitent should fully repent of his guilt, and form at the same time a firm resolution not to sin again, without which repentance and resolution the absolution of the priest is of no avail, being always conditional upon a corresponding disposition on the part of the penitent. It is not therefore true, as it is often erroneously stated, that the priest can absolve from any sins by merely pronouncing the words, "Ego te absolvo." &c.; it is the penitent who, by his contrition and trust in the merits of the Saviour only, can give effect to the words of the priest, and in this respect the principle is common to all the Christian churches, except the formula of the absolution, which differs in some, while others omit it altogether. [ABSOLUTION.] The indispensable condition for obtaining absolution is often explained and inculcated from the pulpits and chairs of theology in Roman Catholic countries, though it happens of course that ignorant or weak people overlook or misconceive the absolute necessity of inward contrition, and think that by merely confessing their sins and reciting the formula of repentance with their lips, they have acquitted themselves of their part, and that the priest can do the rest. Again, the priest absolves "à culpa, sed non à pœnâ;" he removes the guilt, but not the punishment, here or hereafter; and accordingly Roman Catholics admit a purgatory. The penance which the priest imposes consists generally of satisfaction to be given if the penitent has injured any one in his property, honour, &c., in a manner that can admit of reparation, and also of prayers, abstinence, or other religious practices to be performed. The secrecy imposed on confessors is strict and unconditional; whatever be the crime of which a penitent may accuse himself, they are solemnly bound to keep it secret, under the most severe denunciations and penalties, both here and hereafter, that of excommunication *ipso facto* included. Notwithstanding the number of individuals who have exercised the office of confessors all over the Roman Catholic world, and the manifold temptations to which they are exposed, there are few authenticated instances of their having betrayed their trust. That there may be other inconveniences likely to result from private confession, is another question, which it is not our business to discuss. Every priest is not a confessor, although every incumbent of a parish is. The qualifications of age, studies, character, &c., required in a candidate for the office of confessor, the solemn engagements he enters into, and the formalities with which he is consecrated by the bishop, may be seen in the professional works of discipline of the church of Rome, and, among others, in the 'Bibliothèque Sacrée' des Pères Richard and Giraud, Paris, 1825 art. "Confession" and "Confesseur."

The box in which the priest sits in the church to hear the penitent is called the confessional. But the act of confession may be performed out of church, in private houses, in the field, in any place in short, provided it be not within hearing of any person except the priest and the penitent.

The Greek Church retains the practice of auricular confession, but differs from that of Rome in the form of the absolution. The Protestant and Reformed Churches, including those of England and Scotland, do not admit the practice, but recommend every one to confess his sins to God, and to repent in order to obtain forgiveness.

Confession is also the name given to the solemn profession of faith of various Christian churches which dissent from that of Rome, such as that of the reformed churches of France, in 40 articles, signed by Henry, king of Navarre, the prince of Condé, Coligny, and others, and presented to Charles IX. in 1561; that of the Helvetic reformed churches proclaimed in 1566 [ZWINGLI, in BIOG. DIV.]; that of the churches of the Netherlands, consisting of 37 articles, published in 1562, afterwards approved and signed by the members of the synod of Embden in 1571, and lastly examined and confirmed in 1691 by the synod of Dordrecht, or Dort, which condemned the five articles of Arminius. [ARMINIUS, in BIOG. DIV.]; and also that of the Protestant churches of Poland, printed in 1570 at Debrzin, and afterwards approved at the synod of Sendomir.

The most celebrated is the *Confession of Augsburg*, the name given to the profession of faith of the Protestant Lutheran Church, which was drawn up by Melancthon, with Luther's approbation, in order to be laid before the Emperor Charles V. at the great Diet held at Augsburg in June, 1530. It was on that occasion solemnly read in the German language by the Chancellor of Saxony, after which two copies of the Confession, one in German and the other in Latin, were delivered to the Emperor, bearing the signatures of John Elector of Saxony, George Marquis of Brandenburg, Ernest Duke of Luneberg, Philip Landgrave of Hesse, and Wolfgang Prince of Anhalt; besides those of the free town of Nuremberg, and other cities. The Confession was immediately afterwards printed, and, being translated into various languages, was spread over Europe. It has ever since continued to be the rule of the Lutheran Church in matters of faith. It consists of twenty-eight articles, twenty-one of which state the belief of the Lutherans on the principal tenets of religion; and the other seven consist of refutations of certain points of either dogma or discipline as maintained by the Roman Catholic Church, and on account of which the Lutherans separated from the communion of Rome. Zwingli and the other Swiss and French reformers did not subscribe to the Confession of Augsburg, as they differed from it on several points, particularly about the Lord's Supper. The style of the Confession is clear and fluent; the matter was chiefly supplied by Luther in the seventeen articles of Torgau, which he had presented to the Elector of Saxony the year before. Melancthon, while drawing up the Confession, had frequent conferences with Luther, who was then staying at Coburg, not far from Augsburg. The Papal theologians, headed by Faber, wrote a confutation of the Augsburg confession, which was likewise read before the Diet in August of the same year. Melancthon answered them in his 'Apology for the Augsburg Confession,' which was published in 1531, and which constitutes one of the books of authority of the Lutherans which were published, including the Confession, at Dresden, in 1580. Ernest Solomon Cyprian has written a good history of the Augsburg Confession, and Webber a 'Critical History' of the same, Frankfurt, 1783. (Schrœckh's 'Kirchengeschichte;' Mosheim's 'Ecclesiastical History, and Notes,' by Dr. Murdoch; and Neander's 'Church History.')

Some sepulchres of martyrs have been styled by antiquaries confessions; for instance, the subterraneous chapel, in which are the sepulchres of St. Peter and St. Paul, under St. Peter's at Rome, is called "the Confession of St. Peter."

CONFIRMATION is, according to the Church of England, "the rite of laying on of hands upon those who have been baptised, and are come to years of discretion." Such only are qualified to be confirmed as can say the Creed, the Lord's Prayer, the Ten Commandments, and the Church Catechism; to the end that children having learned what their godfathers and godmothers promised for them in baptism, they may themselves ratify and confirm the same; acknowledging themselves "bound to believe and to do" all which those persons undertook for them. It is affirmed in the sixtieth canon of the Anglican church, that confirmation is "a solemn, ancient, and laudable custom in the church of God, continued from the apostolic times." On the other hand, among the Protestant Dissenters it is regarded merely as the remnant of a Popish ceremony; with the assertion, that there is no more authority for that which is retained of it than for that which is rejected. The passages of scripture which are always adduced in support of this episcopal imposition of hands are the three following; namely, Acts viii. 14-17; Acts xix. 6, and especially Heb. vi. 1, where *ἐπιθεσις χειρῶν*, "the imposition of hands," appears to be mentioned as an important rite of the Christian religion. But Dissenters disallow this mode of proving the propriety of the imposition of episcopal hands. They deny it to be a legitimate inference from the miraculous act of inspired Apostles to the act of modern bishops. What warrant, they ask, has a bishop to declare that God has given unto an assemblage of several hundreds of individuals "the forgiveness of all their sins," because they can say the Church Catechism? (See on this question, Towgood's 'Letters on Dissent;' De Laune's 'Plea for the Nonconformists,' &c.) Dr. Whitby observes that, unless the Apostles laid hands on all who were baptised, it makes nothing for confirmation; and that if they did, then Simon Magus received the Holy Ghost. The early fathers certainly believed the Holy Ghost to be indeed conveyed by the imposition of hands. "When we come out of the water," says Tertullian ('De Baptismo,' c. 7, 8), 'we are anointed with the holy chrism (perunguimur benedicta unctione), then we have the imposition of hands, which calls down the Holy Ghost (tradit Spiritum Sanctum Paracletum)." ('De Resurrec. Carnis,' c. 8; Hieron. 'advers. Lucif.,' tom. ii., p. 47; Cyprian, 'Epist.' 73-74 ad Jub., and 72 ad Steph.) Confirmation was originally thus administered immediately after baptism, of which it formed the concluding rite or complement, and was called *βεβαίωσις*; that is, confirmation; nor was there any exception to this time of administering it in the case of baptism in infancy. In the Greek church, and in Asia, it still accompanies baptism. The remonstrance of the Protestants at the Reformation caused the rite to be discontinued to infants, and to be administered only to adults; and afterwards the Council of Trent altered the time for confirmation to the seventh year.

The earliest mention, by the Fathers, of the use of chrism or sacred ointment in confirmation is believed to be in the passage of Tertullian 'de Baptismo,' already quoted (Bingham, b. xii., c. 3); but the church of Rome adduces the authority of the Epistle of James v. 14. The anointing the forehead with this holy unction, which was composed of oil and balsam, constituted the first act of the ceremony of confirmation. The consignation, or signing with the sign of the cross, was the second; and the third and last was the imposition of the bishop's hands, with the invocation of the Holy Ghost. The person was then qualified to partake of the eucharist. Confirmation in the Greek church is named *μυρὸν*, "ointment;" *χρίσμα*, "unction;" *μυρὸν τοῦ χρίσματος*; *σφραγὶς*, "the seal;" and *ἐπισφράγισμα*. In the Roman church this rite is one of their seven sacraments, and it consists in the bishop's anointing the forehead of the person, saying, "A. B., I sign thee with the sign of the cross, and confirm thee with the chrism of salvation, in the name of the Father, and of the Son, and of the Holy Ghost." The bishop then gives a slight blow on the cheek, and concludes with pronouncing the words Pax tecum, "Peace be with thee."

Lord King, in his 'History of the Primitive Church,' p. 91, has shown that confirmation was originally the same thing as absolution, and that it was frequently repeated on the same individual. On the reiteration of the rite, see also Morinus 'De Pœnitentiâ et Ordinatione,' l. 9.

The Puritan contempt for the hierarchy occasioned confirmation to become greatly neglected after the Protestant Reformation in England (Hooker, l. 5, 66; Bishop Hall's *χειροθεσία*); but subsequent to that period the Church of England has observed the rite with much more strictness than the Lutheran or any other church. In Germany it was not generally adopted till the middle of the 18th century.

Du Pin ('Study of Divinity,' p. 216) gives a numerous list of writers on the subject. (Bingham's 'Origines Ecclesiasticæ,' vol. iii., p. 286, *et seq.*; Hammond 'De Confirmatione;' Bishop Parker 'on Confirmation;' Goar's 'Euchologia,' p. 368; Gratian, 'Concordantia Discordantium,' part iii.)

CONFIRMATION (in law). [DEED.]

CONGÉ D'ESLIRE (or D'ÉLIRE), a term in Norman French, literally signifying "leave to elect," which is appropriated to the king's writ or license to a dean and chapter to elect a bishop, at the time of the vacancy of the see. The right of nominating to bishoprics was in most countries of Europe enjoyed by the temporal sovereigns, with little opposition from the ecclesiastical authorities, until the 11th century, when a contest began between the popes and the monarchs of Europe, which, in the next century, ended in the latter being compelled to surrender this important privilege to the clergy. Father Paul ('Treatise of Benefices,' c. 24), says that between 1122 and 1145, it became a rule almost everywhere established, that bishops should be chosen by the chapter. In England, by the constitutions of Clarendon, in 1164, the election was vested in the chapters, subject to the king's approbation of the object of their choice. The right of election was afterwards formally surrendered to the chapters by a charter of King John, by which however he reserved to himself, among other things, the right of granting a congé d'eslire, and of confirming the choice of the chapter. This grant of freedom of election was expressly recognised in Magna Charta, and also by a subsequent statute, 25 Ed. III., stat. 6, which was passed for the purpose of preventing the popes from interfering with the elections to dignities and benefices in England.

So the law stood until the passing of 25 Henry VIII., c. 20, which, though repealed in Edward the VI.th's reign, was afterwards revived, and by which episcopal elections are regulated at the present day. By this Act it is provided that upon every avoidance of an archbishopric or bishopric the king may grant to the dean and chapter a license under the great seal to proceed to the election of a successor, and with the license a letter missive containing the name of the person whom they are to elect. If the dean and chapter delay their election above twelve days after receiving the license, the king may, by letters patent, nominate any person whom he pleases to the vacant see; if they delay the election beyond twenty days, or elect any other person than the candidate recommended by the king, or do anything else in contravention of the Act, they incur the penalties of a præmunire. Bishoprics in Ireland are donative by letters patent, without a congé d'eslire. ('Irish Stat.,' 2 Eliz., c. 4.)

CONGESTION, a preternatural accumulation of blood in the capillary vessels of the sanguiferous system, attended with disordered function of the organs in which such an accumulation takes place. The main functions of the sanguiferous system are performed by the ultimate divisions of the blood-vessels, called, from their hair-like minuteness, *capillaries;* the office of the main trunks and the larger branches of the blood-vessels being merely to convey to the capillaries the material acted upon by them in the various processes which they perform. In the natural and healthy state of an organ, the arterial capillaries in which the arterial trunks that supply it with arterial blood terminate, receive a certain quantity of blood; retain that blood a given time; and then transmit it with a given impetus into the venous capillaries, which in their turn convey it into the larger venous branches, and these to the heart with a given degree of velocity. Upon this transmission of the blood to and from the organs in a given quantity and a given time, depends the balance of the circulation; upon the due balance of the circulation depends the healthy condition of the organic processes; and upon the healthy condition of the organic processes depends the sound performance of the animal functions.

Of the mode in which the balance of the circulation is disturbed by the preternatural accumulation of blood in the capillary vessels, some conception may be formed by observing the phenomena that take place when a mechanical or chemical irritant is applied to a transparent part of the animal body; and when such a part is brought under the field of the microscope, so that the circulation in the minute vessels can be distinctly seen. In this case, the first phenomenon observable is a quickened circulation in the part, and the consequent determination to it of a greater quantity of blood; next, after a time, the blood-vessels are seen to dilate and to become turgid with blood; and in the third place, the flow of blood through these distended vessels is manifestly retarded; and ultimately, if the irritating cause continue to operate with a certain degree of intensity, the circulation is wholly stopped. The quickened circulation, the first phenomenon that takes place, is occasioned by the action of the contractile power inherent in the coats of the capillary vessels, excited in an inordinate degree by the application of the unusual stimulus. The dilatation of the capillary vessels, the subsequent event, arises from a diminution of the vital power of the coats of the vessels, from the over-excitement produced by the irritating cause.

The blood-vessels in this state are commonly said to have lost their tone; to be debilitated or weakened. The consequences of this loss of vital power in the living tissues that form the walls of the blood-vessels, are the engorgement of the vessels, the impeded, retarded, or abolished circulation of blood through them, and the disordered or suspended function of the part affected.

From the preceding statement, a distinct conception may be formed of that morbid condition of the blood-vessels, to the designation of which the term congestion is commonly applied. How greatly such a condition of the blood-vessels must disturb their natural functions, and consequently how powerful an agent it must be in the production of disease, it is also easy to conceive. But pathologists have hitherto made but slight progress in determining with precision the nature of the morbid changes which take place, either in the blood-vessels themselves, or in the tissues in which, as a consequence of this affection, an alteration of structure is sometimes ultimately superinduced.

From an observation of the phenomena connected with the state of congestion, it is usually distinguished into passive and active. When there is merely an accumulation of blood in the distended and debilitated capillaries, without any other manifest morbid phenomenon, the state is called simple congestion; and this state of congestion is commonly said to be passive. But when to this accumulation of blood there are superadded certain phenomena which accompany and which characterise another morbid state, namely, inflammation, the congestion is termed active. In active congestion, the blood-vessels themselves are in a state of excitement; the preternatural quantity of blood they contain is determined to them by their own inordinate activity; they are in a condition not of diminished but of exalted vital energy. In passive congestion, on the contrary, the coats of the vessels are destitute of their natural tonic, vital resistance; yield readily to the current of blood which is determined to them, or unable to pass on the current they receive, the blood accumulates in them and distends them. Active congestion, according to this account, however, can be distinguished by no certain and even no appreciable character from inflammation, a state which is always supposed to be different from congestion. [INFLAMMATION.]

The tissue of the body in which the state of congestion is most apt to occur, is the cellular, and more especially in the lax and little cohesive condition in which this tissue forms the parenchyma of the different internal organs, as the brain, the lungs, the liver, the spleen, the kidneys, and so on. A congested state of their blood-vessels is also peculiarly apt to occur in the mucous membranes, and more especially in the mucous membranes of the bronchi and air vesicles of the stomach and the alimentary canal, and of the ovaria and uterus. But besides these, other and less yielding structures, as the serous and fibrous membranes, the skin, and even the muscles, may be affected with congestion, after the operation of causes which have exhausted the vital energies of the system in general, or which have diminished the vital cohesion of these structures in particular.

Congestion, when present to any considerable extent, and when continuing for any length of time, disorders the function of the organ in which it takes place. The signs of this disordered function are signs from which it is inferred that congestion is present. If, for example, the blood-vessels of the brain be in a state of congestion, the activity and energy of the cerebral functions will be diminished, indicated by dulness, heaviness, forgetfulness, inaptitude for mental labour, giddiness, lethargy, and so on; and if the congestion be in great intensity, it may produce all the symptoms of coma and even of apoplexy. [APOPLEXY; COMA.] If the blood-vessels of the liver be in a state of congestion, the secretion of bile will be disordered; altered in quality, diminished in quantity, or entirely suppressed. If the blood-vessels of the mucous membrane of the air passages be in a state of congestion, it will occasion uneasiness in the chest, difficulty of breathing, cough, &c.

Congested states of these and other organs are exceedingly apt to occur in the progress of other diseases, more especially in the different types of fever, the character of which they modify, and the severity and danger of which they always greatly increase. There are fevers, indeed, and those of the very worst kind, that is, the most intense and the least under the control of any known remedies, in which a high degree of congestion of the blood-vessels of the brain, of the lungs, of the liver, or of the mucous membrane of the intestines, is among the very first appreciable morbid conditions of the system; but in general such a congested state of the blood-vessels is consequent upon preceding morbid conditions of the organs; conditions by which the vital energies of the blood-vessels have been exhausted.

The appearances presented by congested parts after death, vary with their structure and with the degree and duration of the affection. The capillary arteries and veins are turgid with blood; the blood they contain is of a darker colour than natural; hence the colour of the organ, the seat of the congestion, is darker in proportion to the intensity of the affection; it is also commonly more or less swollen, and the cohesion of its tissues is diminished, so that they are more readily torn than when in a healthy condition. In some organs, indeed, as in the liver and the spleen, when the congestion is in an extreme degree, the cohesion of the component tissues is so much lessened that the organs are broken down on the slightest pressure.

Anything may be the cause of congestion which diminishes the vital energy of the capillary vessels; or which changes, beyond a certain limit, the quantity and quality of the blood they contain. If the vital energy of the capillaries be diminished, they cannot maintain the tension necessary to prevent distension of their parietes, and a consequent preternatural accumulation of blood. If the quantity and quality of the blood they contain be altered, their natural stimulus may be so deficient as not to excite, or so excessive as to exhaust them. For the treatment of congestion, see INFLAMMATION.

CONGREGATION most commonly signifies an assembly of persons for the purpose of public worship and religious edification. It denotes more particularly a number of ecclesiastics constituting a legislative and executive body; and in this acceptation it is applied chiefly to certain boards of administration consisting of cardinals and of prelates, or aspirants to the cardinalship in Rome. These congregations serve as a check on the papal authority; for though their proceedings are usually sanctioned by the pope, he cannot, without alleging the weightiest reasons, put a veto on them. The whole number of these congregations is twenty-one; that is, fifteen for spiritual and six for temporal purposes. Congregation is also used to designate a company, society, or fraternity of monks forming a subdivision of an order, as the congregation of the Oratory, or of Cluny among the Benedictines. The Congregation of the Lord was an appellation assumed by the Scotch Presbyterian Reformers, who called the Church of England the congregation of Satan. They appeared first in 1557, under the Earl of Argyle, and were subsequently led by John Knox.

Congregationalists are those who compose the congregations which assume an independence not only of the ecclesiastical control of the established hierarchy, but of all authority extraneous to the constituency of the congregation itself. They may therefore in general be said to be identical with the Independents. They are said by some to have appeared first in 1616, under the conduct of Mr. Jacob. (Evans's 'View.') But they are generally considered to be of the same origin as the Brownists, who appeared in 1600. [BROWN, ROBERT, in BIOG. DIV.] The real founding of this sect is attributed to Mr. Robinson, in 1640, and the following passage from his 'Apology' (c. 5, p. 22) is adduced as their leading maxim: "Cœtum quemlibet particularem esse totam, integram et perfectam ecclesiam, ex suis partibus constantem immediatè et independenter sub ipso Christo." It is said that they adopted the name of congregational brethren, and congregational churches, to avoid the odium of sedition and anarchy which was charged upon them as the Puritan regicides of Charles I. Cromwell made use of them as a political check on the Presbyterian party. (See 'Declaration of the Faith and Order owned and practised by the Congregational Churches in England,' 1658.) In the six New England states of North America, which were colonised by the English Puritans, the Congregationalists are very numerous; and in several other parts of the Union their numbers are much larger than those of other sects. Their creed and the rules of their democratic government are given fully in their 'Platforms of Discipline.' They believe in "The Trinity; Predestination; Total Depravity; Particular Redemption; Effectual Grace and Final Perseverance;" and maintain that "Every congregation of visible saints, furnished with a pastor, is under no other ecclesiastical jurisdiction whatever."

(Mosheim, cent. 17, § ii. part ii.; Neal's *Hist. Puritans;* Burnet's *Hist. Own Times;* Adam's *Dict. of Religion.*)

CONGRESS, an assembly of envoys delegated by different courts with powers to concert measures for their common good or to adjust their mutual concerns. The term is given also to a meeting of sovereign princes which is held for the like purpose. The delegates from the Assemblies of the British colonies who met at New York, 7th October, 1765, to consider their grievances, called their assemblage a Congress. A second congress, which assembled in June, 1774, and sat for eight weeks, published a Declaration of Rights. Another congress met in May 1775, which proceeded to organise the military and financial resources of the colonies; and thus these assemblies of delegates exercised the functions of a supreme government, and under their authority the war of independence was brought to a successful termination. In 1789 the constitution was re-organised, and a congress of two houses was formed. [UNITED STATES OF NORTH AMERICA, in GEOG. DIV.] The meeting of envoys or plenipotentiaries which precedes a treaty of peace is sometimes called a Congress; but the term is more generally applied to such meetings when they have to settle, either before or after the peace, an extensive plan of political arrangements and re-organisation. This was the business of the Congress of Vienna in 1815. Sometimes a meeting of sovereign princes or plenipotentiaries takes place to concert a certain line of political action, and this is also commonly termed a Congress. Examples of these are furnished by the Congress of Carlsbad, 1819; of Troppau and Laybach, 1820, and of Verona, in 1822.

CONIA. The active principle of hemlock appears to be an alkaloid termed *conia*, which, unlike most vegetable alkaloids previously known, is not fixed and crystalline, but volatile and oleaginous. It has been obtained both from the leaves, and fully developed but still green fruits. Its activity is increased by union with acids, both mineral and vegetable; a circumstance which shows the impropriety of giving vinegar as an antidote in cases of poisoning by hemlock, when any of the substances is yet present in the stomach. Conia is sparingly soluble in water, to which it imparts its odour and taste. It also combines with about a fourth of its weight of water to form a hydrate of conia. The salts of conia are very soluble in water, but rapidly undergo decomposition, so as to become innocuous; water is therefore an improper vehicle for their exhibition. When exposed to the air it quickly contracts a dark brown colour, and is slowly resolved into a resinous matter, with the disengagement of ammonia. This change takes place more promptly under the co-operation of heat; but even at common temperatures it is so apt to ensue, that unless the alkaloid be kept very carefully excluded from the air, discoloration will take place in a few hours. Though conia exists in the plant in combination with coniic acid, which may render it less alterable, yet its proneness to decomposition is so great, that either by time or the application of a considerable degree of heat, it may be entirely dissipated; which accounts for the inertness of old leaves, and of most extracts which have not been prepared with the greatest care. Geiger says that the dried leaves do not contain conia; a statement which, if correct, leads to the conclusion that conia, though the most powerful, is not the only efficient agent in hemlock.

Conia appears, from the experiments of Geiger and Christison, to be a deadly poison to all animals. It acts with the most extraordinary rapidity; but if it fail to kill, its injurious action passes quickly away, and perfect recovery follows. It acts through every texture of the body where absorption is readily carried on. It acts as a local irritant; but its ultimate and fatal energy is chiefly exerted on the spinal chord, to which its influence is conveyed by entering the blood and producing on the inner membrane of the blood-vessels a peculiar nervous impress on, which is instantly conveyed by sympathy along the nerves to the organ remotely and ultimately affected. "It exhausts the nervous energy of the spinal chord, producing general muscular paralysis and asphyxia from relaxation" The heart, however, is exempt from this general paralysis, contracting vigorously for a long time after all motion and respiration and other signs of life are extinct. It is, therefore, extremely probable, as suggested by Dr. Christison, that where a dose is not so large as to produce immediate death, the carrying on of artificial respiration and administering vital stimulants, might save the life of the patient, especially as the action of the poison is so transient, and incapable of producing a permanently injurious impression.

Infusion of galls, or strong black tea, if speedily administered, might prove an antidote.

CONIC SECTIONS, the curves formed by the intersection of a circular cone and a plane, either oblique or right.

Though the name of conic sections still remains, yet the interest which attaches to these curves, and the method of treating them, has no longer any reference to the accident from which they derive their name. The Greek geometers, in pure speculation, occupied themselves with the different methods in which a cone may be cut, simply because the conical surface (with the cylindrical and spherical) came within the restrictive definitions under which they had placed geometry. [GEOMETRY.] The works of APOLLONIUS and ARCHIMEDES [BIOG. DIV.] are the first in which these sections were treated; and their subsequent history is nothing but that of the addition of a few remarkable properties, until the discovery that the path of a projected body in an unresisting space is a parabola, and that of a planet round the sun an ellipse. [GALILEO, and KEPLER, in BIOG. DIV.] Since that time we might as well attempt to write the history of mathematics and physics as that of conic sections in their results and consequences; and from that time we have nothing to say of them merely as *conic sections.*

Some sections of a cone are considered in elementary geometry; for a plane may meet a cone in a point, or in a single straight line, or in two intersecting straight lines, or in a circle. But the curves which are peculiarly conic sections are, the oval made by a plane which cuts the cone entirely on one side of the vertex, called the ELLIPSE; the indefinitely extended modification of this when the plane becomes parallel to any one slant side of the cone, called the PARABOLA; and the curve which is partly on one side and partly on the other of the vertex, formed by a plane which cuts both surfaces of the cone, called the HYPERBOLA. To these names we refer for the specific properties of the sections.

Algebraically considered, the *conic sections* are the *curves of the second degree,* meaning the curves belonging to such equations between co-ordinates are of the second degree. Thus, x and y being co-ordinates, oblique or rectangular, the general equation

$$a\,x^2+b\,x\,y+c\,x^2+d\,y+e\,x+f=0,$$

may, by properly assuming a, b, c, &c., be made the equation of every possible section of a cone by the plane in which the co-ordinates are measured. As very many elementry works do not fully discuss the conditions under which the preceding equation represents the different sections, we subjoin the following from the 'Camb. Phil. Trans., vol. v., p. 89. In the following list, θ means the angle made by the co-ordinates:—

$$\text{Let } \mathrm{v}_1=a+c-b\cos\theta \qquad \mathrm{v}_2=4\,a\,c-b^2;$$

$$\mathrm{w}'=\frac{c\,d^2+a\,e^2-b\,d\,e}{b^2-4\,a\,c}+f,$$

and in the case where v_2 and $c\,d^2+a\,e^2-b\,d\,e$, are both $=0$, let

$$\mathrm{w}''=\frac{4\,a\,f-d^2}{4\,a}=\frac{4\,c\,f-e^2}{4\,c}.$$

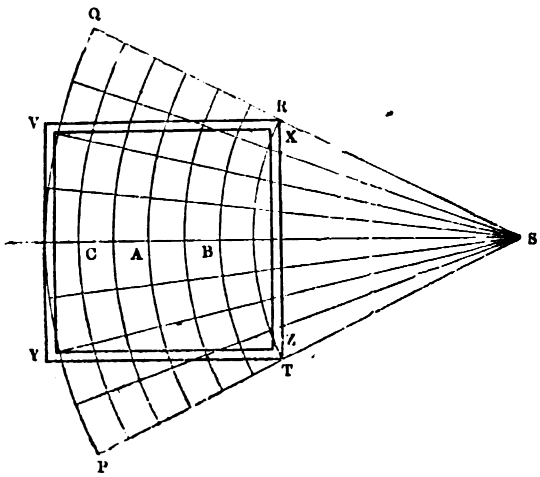
In the following table, p means either sign, + or —, but in the same line, n means the other sign; a dotted line means that the sign of the expression at the head of the column need not be considered. The word line by itself means straight line.

W'	V_2	W''	V_1	Name of the Section.
p	+		p	Impossible.
p	+		n	Ellipse.
p	—		..	Hyperbola.
a	0		..	Parabola.
0	+		..	Point.
0	—		..	Intersecting lines.
$0 \div 0$	0	p	p	Impossible.
$0 \div 0$	0	p	n	Parallel lines.
$0 \div 0$	0	0	..	Line.
$0 \div 0$	0	x	..	Line.

Thus if w' and v_1 both have the same sign, and v_2 be positive, the equation cannot be satisfied at all; but if w' and v_1 be of different signs, and if v_2 be positive, the equation is that of an ellipse. We may add that $\mathrm{v}_1 = 0$, indicates an equilateral hyperbola. [HYPERBOLA.]

The general properties of the sections are numerous and interesting, but we shall only mention one, because it is the most convenient as a general definition of the curves, combining them at once with each other, in a manner to which algebra is easily applied. If a point move in such a way that its distance from a given point (called the *focus*) always is the same fraction of its perpendicular distance from a given right line (called the *directrix*), then the curve traced out is an ellipse, parabola, or hyperbola, according as the given fraction is less than, equal to, or greater than, unity. We are convinced that no method of deducing the properties of these curves can be very successfully applied in the case of beginners, unless it involve the foci in the definition. The properties of these points do not readily show themselves either in the deduction from the cone or from the general algebraic equation.

CONICAL PROJECTION, a method of describing a representation of a part of a sphere upon a plane. A sphere cannot be unrolled into a plane, as can every cone or portion of a cone. If a cone be described which touches a sphere in a small circle, and if the several points of the sphere be then projected upon the cone by lines drawn through the centre, the parts adjacent to the small circle of contact will be projected into figures very nearly similar to the originals. If the degrees of latitude, which are very nearly equal, be made actually equal, no injurious effect will be produced on the map. Suppose, for instance, it is required to draw the map of a country contained between two given longitude circles, and two given parallels of latitude.



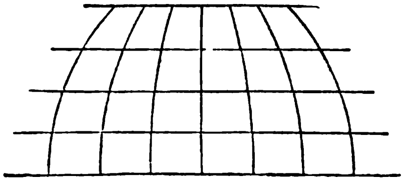
Take any radius for the sphere, and let S A be the radius × cotangent of the middle latitude of the map. From A set off A B, A C, &c., equal to the arc of one degree (or whatever the distance may be between the parallels which it is desired to draw) on the great circle of the sphere chosen. Let L° be half the total longitude contained between the extremities of the map, and take the angles A S P and A S Q, equal to L° × the sine of the middle latitude. Divide the angle Q S P into as many parts as there are degrees (or other required intervals of longitude lines) in L; then Q R T P is the map required, and V X Y Z such a portion as is usually exhibited on a sheet of paper.

If, instead of the tangent cone, it be required to project upon the cone formed by the revolution of the chord which joins the two extreme points of the map on the sphere, let l and l' be the least and greatest latitudes, and let

$$\text{S R} = \text{radius} \times \cos l' \div \sin \tfrac{1}{2}(l+l')$$
$$\text{S Q} = \text{radius} \times \cos l \div \sin \tfrac{1}{2}(l+l')$$

the rest is as before.

There are two modifications of this principle which it will be convenient here to notice,—the projection used by Flamsteed, and that adopted by the French government in their recent maps. In Flamsteed's projection the degrees of latitude are equal, and the parallels of latitude are perpendicular to the middle longitude circle, which is a vertical right line. But the degrees of longitude are made in every parallel to bear the same proportion to the degree of latitude as on the globe; so that the meridians are, in fact, curves, the ordinates of which are as the cosines of the abscissæ.



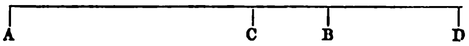
In the French government maps the same plan is adopted, with this exception, that the parallels of latitude are the circles of the conical projection, and the degrees of latitude are all equal (the oblateness of the earth may be allowed for, if thought necessary); the degrees of longitude are then set off on the parallels of latitude in the same proportion as in Flamsteed's projection.

CONINE, *Conicine, Conia, Conicina* ($C_{16}H_{15}N$). An alkaloid obtained from hemlock (*Conium maculatum*). It is procured from the seeds or fresh leaves of the plant by distillation with water holding some potash in solution. When pure it has the following properties: It has the appearance of a colourless volatile oil, and is lighter than water, its specific gravity being 0·89. Its odour is powerful, diffusible, and repulsive, somewhat like that of hemlock itself. It is intensely acrid to the taste. It has a strong alkaline reaction on turmeric paper. It combines readily with and neutralises acids; and some of the salts which it forms with them have been obtained in a crystalline state. It is sparingly soluble in water, and what is remarkable is, that it is more soluble in cold water than in hot. It imparts its odour and taste to water. Alcohol mixes with it in all proportions; and it also dissolves readily in ether. With about one-fourth of its weight of water it forms a hydrate. By exposure to the air it quickly becomes of a dark colour, and spontaneously decomposes with the evolution of ammonia. Its boiling-point is 370° Fahr. It distils, however, with boiling water, but suffers partial decomposition.

It is one of the most virulent poisons known, destroying small animals by a very small quantity and in a very short time.

Hemlock also appears to contain a second base, *methyl-conine* ($C_{18}H_{17}N$); whilst, by acting upon conine with iodide of ethyl, a third base, *ethyl-conine* ($C_{20}H_{19}N$), may be obtained.

CONJUGATE. This word is used in several branches of mathematics in a sense which (with one exception, and that might easily be abolished) may be described as follows: Two points, lines, &c., are called conjugate, when they are considered together in any property in such a manner that they may be interchanged without altering the way of enunciating the property. Thus, if A C be to C B as A D to D B, C and D are conjugate points with regard to this property.



If we write D where C now is, and C for D, the property is still expressed in exactly the same way. We have other instances in conjugate diameters, conjugate hyperbolas [ELLIPSE; HYPERBOLA], conjugate foci [LENS; MIRROR].

The instance of exception is the conjugate point of a curve, meaning a single point lying by itself, whose co-ordinates satisfy the equation of the curve, without its actually being on any continuous branch of the curve. [CURVES, THEORY OF.] It would be better to call this point *conjunct* than use a term which destroys the generality of language. But the best term, in our opinion, would be *evanescent oval.* [See the article already cited.]

CONJUGATION of a verb is a term in Grammar, denoting the addition of suffixes or prefixes to the crude, or elementary form of a verb, for the purpose of denoting respectively, person, number, time, state, mood, and what is generally understood by voice. In the English language prefixes are commonly used for these purposes, and these prefixes are not printed in connection with the verb, though the voice presents them in one mass. Thus, *I shall have heard,* as pronounced, is not less one word than the Latin *audi-v-er-o.* In this example, therefore, *I, shall, have,* are virtually prefixes, and the letter *d,* a contraction from *ed,* or rather *de,* is a suffix attached to the simple verb or crude form *hear.* In the ancient languages, such as Greek, Latin, and Sanscrit, suffixes are commonly but not exclusively preferred.

The suffixes which denote the *persons* are the personal pronouns more or less corrupted. Thus, in Latin, *egomet* is the full form of the pronoun which signifies *I;* but as three syllables would be too long for a term in such frequent use, and this inconvenience in the present instance would be aggravated by an appearance of egotism, the word was shorn of its exterior letters, and at the utmost the three middle letters, *ome,* were attached to the verb. We see them in the Greek form *tupt-ome-s,* or *tupt-ome-n,* " we strike." In the Latin, the vowels were corrupted, so that instead of *ome,* either *umu* or *imu* occur, as in *-umu-s,* " we are;" *poss-umu-s,* " we are able;" *scrib-imu-s,* " we write." The old German has nearly the same suffix in *war-ume-s,* " we were;" *bir-ume-s,* " we be." Again, the three letters, *ome,* deprived of the last vowel, became *om,* as Greek, *tupt-om-ai,* " I strike myself;" *um,* as Latin, *s-um,* " I am;" *poss-um,* " I am able;" also *am,* as seen in *inqu-am,* " I say;" and *on,* as Greek, *e-tupt-on,* " I was striking." But the first vowel might disappear instead of the last. Thus, *me* is the form which appears in the Greek *es-me-n,* or *es-me-s,* " we are;" *mi* is used in *es-mi, ei-mi,* " I am;" *di-do-mi,* " I give," &c. Sometimes the *m* is all that appears, as *scribeba-m,* " I was writing." In Greek, this final *m,* by a principle constantly observed in that language, becomes an *n,* as *ē-n,* " I was;" *etetuphei-n,* " I had struck." Another form of the suffix is *o,* instead of *om,* which is common both in the Greek and Latin,—as Greek, *tupt-o,* " I strike;" Latin, *scrib-o,* " I write." Finally, all trace of the pronoun at times disappears, and the defect ceases to mislead because the other persons have their characteristic terminations. Thus the Greek tenses, *etupsa,* " I struck," *tetupha,* " I have struck," and *etetuphea,* " I had struck," contain no remnant of the pronoun. In the English language there are some slight traces of the personal suffixes, which existed in full perfection in some of the older forms of the Teutonic languages. The word *am,* for example, has a remnant of the first person suffix in its final *m.*

The second person in the Greek and Latin languages was *su* or *tu;* in German, *du;* and in English, " thou." Accordingly, we find a sibilant attached to the verb to denote the second person, as in the Greek, *es-si,* " thou art;" *ois-tha,* " thou knowest;" *tupt-es-ai,* " thou strikest thyself;" in the Latin, *scrib-is,* " thou writest;" and in the

English termination *est* in *knowest, strikest.* But as the Latin form has a *t* instead of an *s*, *tu* not *su*, so the *t* occasionally appears as in Greek, *tupt-ete*, "you strike;" Latin, *scribiti-s*, "you write;" and in the English, *art*, "thou art."

The third person is an indefinite term, and the suffix which denotes it is derived from *to*, signifying *this*, which is the full form of the Greek article; and again appears, on the one hand in Latin, in the derivatives *tam, talis, tantus, tot, tum;* and on the other, in the English *the, this, to-day.* It is therefore as general as the English article *the*, and may denote indifferently, *the man, the woman, the thing;* in other words, *he, she, it.* It appears as a suffix in the Greek εσ-τι, "he is" (Sanscrit, *as-ti*); τυπτ-ετ-αι, "he strikes himself;" in the Latin, *es-t*, "he is;" *scrib-it*, "he writes;" and in the obsolete form of the English language, *walk-eth*, now corrupted into *walks*.

Suffix of *number*. If a sign be employed to denote plurality, the absence of that sign will be a sufficient indication of the singular. Now the suffixes of plurality in English are *s* and *en*, as in *dogs, oxen.* The same are employed in Greek and Latin, as, first person, Greek, τυπτ-ομε-ς, or τυπτ-ομε-ν; Latin, *scribimu-s;* second person, Latin, *scribiti-s.* The Greek has dropped the *s*, as in τυπτ-ετε, a corruption probably of τυπτ-ετι-ς; just as the Latin imperative *scribite* must be looked upon as reduced from *scribitis.* For the third person we must have in view the older form, *fanti* (φαντι), "they say;" or rather *fantin*, for this final *n* is an essential part of the word, and not, as is commonly taught, a meaningless addition. Thus the four letters *ntin* represent the suffix, of which the final letter denotes plurality, and the remainder is but a variety of the article *to*, "this." The change of the *t* to *n* in this pronoun is not rare, as may be seen in the Latin *nam* and *num* (*nunc*), which in origin are but varities of *tam* and *tum* (*tunc*); and if *n* and *t* are interchangeable, *a fortiori* is *nt* interchangeable with either.

Time or tense (Fr. *temps*) divides itself into past, present, and future, where again the idea of present time will not require any peculiar distinction, if the ideas of past and future have their proper symbols. The past time appears to have had for its characteristic either the prefix, *e*, or the suffix, *a*. The former appears in the Greek, *e-tupt-on*, "I was striking;" *e-tup-sa*, "I struck;" *e-tetuph-ea*, "I had struck." The second appears in two of the Greek forms just enumerated, and in the Latin *scribeb-a-m*, "I was writing;" *er-a-m*, "I was." A very distinct example of a future suffix appears in those European languages which are derived from the Latin. Thus, in the French, *écrir-ai*, we have really two distinct words, the infinitive, *écrire*, and *ai*, the present tense of *avoir*, forming altogether, *écrir-ai*, "I have to write," that is, "I shall write." This origin of the French future is placed beyond a doubt by a comparison with the Spanish and Italian. (See Key's 'Alphabet,' p. 123, &c.)

By the term *state*, which stands forth in the series of suffixes which have been included in the definition of conjugation, it was intended to denote the notions of perfect and imperfect action. Here again one suffix is sufficient, and the notion of completeness is variously marked: 1st. By a doubling of the verb upon itself. The purest example of this is presented in the Gothic, as *laia*, "I laugh;" *lailô*, "I laughed;" *stauta*, "I strike;" *staistaut*, "I struck." The Greek have perfects formed upon this principle in *te-tupha, ge-grapha;* the Latin in *te-tul-i, de-d-i, spo-pond-i* (for the less easily pronounced *spo-spond-i*). And in our own language there is strong reason for believing that such is the origin of *did*, the perfect of *do*. Out of the same principle grows the formation of the perfect by a long vowel, *vēni* being probably a contraction from *vĕ-vĕn-i.* 2nd. By adding the simple tenses of the verb *ĕs*, "be," with an interposed *s*, which by a bold yet highly probable theory may be regarded as the ordinary genitival suffix signifying "from." Thus, *scrip-s-eram* would be "I was from writing," or "I had written;" *scrip-s-ero*, "I shall be from writing," or "I shall have written." So *scrip-s-istis* (*istis* for *estis*), "ye are from writing," or "ye have written." As *s* is a letter very apt to vanish from language, we must not be surprised at its non-appearance in such words as *ven-eram.* Again, the *v*, which presents itself in so many perfects of the Latin language, as *amaveram, monueram*, is probably but the old *w*, which once formed a part of the verb *es*, "be;" witness the German *wes-en*, "existence," and our own *was*.

The suffixes of the moods could not be placed in a distinct point of view without a detailed investigation. It may be sufficient to point out that *to* is distinctly observable as a suffix in one portion of the Latin imperative. That the suffixes of the potential, subjunctive, and optative moods, in the Greek and Latin, were originally distinct words, and perhaps verbs, like our own *may, can*, &c., is probable from general principles, and is confirmed by the appearance of the separate particles *ken, ke, an*, in the Greek language, which are used to denote a sort of potential mood, and bear a marked resemblance to our own *can*.

The last suffix for consideration is that which denotes the *voice*. The Greek grammarians acknowledge a middle or reflective voice; but the Latin language in fact possesses the same, as, for instance, in *accingo-r*, "I gird myself for the contest;" *nito-r*, "I support myself;" *lavo-r*, "I wash myself," "I bathe." And in both languages the middle voice is the parent of the passive. This may be illustrated by such phrases as the French *les bas se vendent ici*, "stockings sell themselves here," that is, "are sold;" the Italian *si dice*, "it is said," strictly *it says itself.* Now, the suffix of the Latin passive appears in the various forms *ur*, as *monet-ur*, *er* as *moneri-er*, *r* as *moneo-r;* but the attentive Latin student is ever ready to suspect when he meets with an *r*, that an older form of the word contained an *s;* and in fact we find an *s* in the form *moner-is*, where, moreover, the first part *moner* is another example of the corruption in question, for it supplies the place of *mones.* If, then, *s* is the original consonant of this suffix, we are forthwith directed to the reflective pronoun *se;* nor ought we to be stopped by the fact that this pronoun in Latin is confined to the third person. In the Russian and other Sclavonic languages, still more in the Lithuanian, the connection of all which with the Teutonic languages and with those of Greece and Rome is indisputable, the reflective pronoun, containing in fact the very same root as *se*, is applicable alike to all the persons; and indeed there was nothing in the nature of things to limit the Latin pronoun as to *person*, when it is confessedly unlimited as to *gender* and *number*.

The division of verbs into several conjugations depends upon the last vowel or consonant of the verb in its simple or crude state. Thus, in the Latin language, all verbs ending in *a* are said to be of the first conjugation, all that end in *e* of the second, those in a *consonant* or *u* of the third, and those in *i* of the fourth or last; for it accidentally happens that the Latin language possesses no verbs in *o*, except the fragmentary forms *gnovi, gnotus, potus, ægrotus*, which appear to imply the existence of stems in *o*, namely, *gno* (in English, "know"), *po* (compare the Greek *pe-po-ka*), *ægro.* The Greek language is not without a class of verbs having *o* for the final letter, as *doulo*, "enslave, &c. The division of verbs into conjugations is founded upon the fact that the union of the final letters in the crude form of the verb with the initial letters in the suffixes leads to changes dependent upon these letters. We will not enter here into the origin of these letters, *a, e, i*, as affixed to verbs. That they form no essential part of the root is clear, and a writer in the 'Transactions of the Philological Society' contends that they have all one common origin in a suffix *agh*, still found in the Gaelic languages with an iterative power, or what may perhaps be better expressed by the Latin *paulatim.* We will here merely note that such verbs are often called by grammarians *weak* verbs, in opposition to the simpler or strong verbs. As specimens of these, we may give the Latin *son-ere* (obsol.) and *sona-re.*

CONJUNCTIONS. Under this term grammarians commonly include several classes of words which have little similarity of meaning, and which, in their etymological origin, may be verbs, substantives, adjectives, or prepositions. The old definition of a conjunction, that it was a word which connected sentences together, will certainly not apply in all cases, if at least the word "and" is to be included. It is true, as Horne Tooke observes, that "the sentence 'You and I and Peter rode to London' may be resolved into three: 'You rode,' 'I rode,' 'Peter rode.' But try some other instances: 'two and two are four;' 'AB, BC, CA form a triangle;' 'John and Jane are a handsome couple.'—Does AB form a triangle?—Is John a couple?—Are two four?" ('Diversions of Purley,' Taylor's edition, i. p. 210.)

On the etymological origin of conjunctions, which is a distinct question from their use, some remarks will presently be made; in reference to their employment in the construction of a simple or compound sentence they may perhaps be divided into the following classes: 1. Conjunctions which unite either individual words, or phrases, or sentences, without, in the last case, implying any subordination of one sentence to the other. Such are the words: *and, or, nor;* or the double forms: *both—and—, either—or—, whether—or—, neither—nor—.* With respect to this class it may be useful to point out the great advantage which the Greek, and more particularly the Latin, language possessed in the variety of their forms for *and:* as και, τε in the former, *et, que, atque* or *ac* in the latter. This superiority over modern languages, simple as it is in itself, gave to the longest Latin sentence a perspicuity of arrangement, which in a great measure superseded the necessity for a cumbersome punctuation. ('Journal of Education,' vol. iv., p. 135.) 2. Conjunctions, which in themselves simply meaning *this*, being prefixed to a secondary sentence or phrase, direct the attention to that secondary phrase as a unit, and thus prepare it for subjection to some preceding word. This usage of the pronoun is as nearly as possible equivalent to the use of the bracket or vinculum in algebra, which connects the separate elements of any compound or polynomial term, and subjects it as a new unit to the algebraical operation, the sign of which is attached to the vinculum. Horne Tooke, in his remarks upon the so-called conjunction *that*, furnishes many examples: as, "I wish you to believe that I would not willingly hurt a fly," which is resolved by him into "I would not willingly hurt a fly; I wish you to believe *that.*" A mathematician would have expressed it by "I wish you to believe [I would not willingly hurt a fly]," where the words within the brackets must be considered as a compound accusative or object after the verb *believe.* The Latin *ut* and *quod* in their origin are merely neuters of the relative, and the original meaning of the relative, it must be recollected, was *this.* [ARTICLE.] Hence they too are used in the same way as the English *that;* for example: *suadeo ut abeas*, "I recommend *this*, you should go away;" *lætatur quod redieris*, "he rejoices at *this*, you have returned." Other examples may be found in the use of the Greek ὁτι, which is again the neuter of a relative, as: λεγω ὁτι τεθνηκε, "I say *this;* he is dead." In Greek there is sometimes a double accusative after the verb, one of which simply denotes the object of the verb, and the other points to the condition or state of the object, as explained by the words that follow it: thus, ὁρω σε ὁτι *κακως πασχεις*, literally, "I see you *this* (that), you are suffering." This employment of the pronoun is more particularly to be noticed after prepositions. Thus, in the Latin language, if a simple noun be the object of a preposition, all that is required is to put that noun in a certain case, as *post cœnam*, "after dinner;" but if a verb with its accessories is to be subject to a preposition, it is common to interpose the vinculum *quam*, "this," as, *postquam cum fratre suo cœnaverat*, "after he had supped with his brother." Even in English we might say: "after that he had," &c. Examples of this usage are abundant in the forms *antequam, prœterquam, extra quam, prœter quod, prout;* and the word *this* is sometimes doubly expressed, as in *pro eo ut, ad-eo ut, propter-ea quod, ex eo quod, prœter quam quod*. The German idiom agrees precisely with the Latin, as may be seen in *nach-dem, in-dem*, &c., as opposed to the employment of the simple prepositions *nach, in*, &c. The French, too, have their *pendant-que*, &c., *puis-que*, &c., and the English their *besides that*, &c., *now that*, &c., and the old phrase *being that*, &c. 3. The pronoun in the several languages thus employed as a vinculum is frequently attached as an enclitic to the preceding word, and grammarians, not observing the distinction between the governing word and the pronoun, have often given the name of conjunction to the compound, as *postquam* in Latin, *διοτι* in Greek, *puisque* in French, *nachdem* in German. 4. The vinculum, however, is not essential in those forms, and is therefore frequently omitted; but in case of this omission the governing word must immediately precede the phrase which is dependent upon it. This governing word, which expresses the nature of the connection between the subordinate and the superior sentence, is also called a conjunction, but here the term is used in a different sense. The words which signify *this*, of which we previously spoke, found their claims to the title of a conjunction upon the fact that they unite the several elements which follow into a whole. When the governing particle is so called, it is because it binds the one sentence to the other. 5. There is a class of words which correlate with conjunctions: such as *so* in connection with *as* or *that*, *yet* with *although, therefore* with *since* or *because*. These words are often called adverbs, but as they too serve to connect sentences, they deserve like the rest the name of conjunctions. They bear, in fact, the same relation to the other conjunctions that the so called antecedent does to the relative. And that the antecedent and relative have the power of conjunctions is proved not merely by their use, but by their old and appropriate names, the postpositive and prepositive articles (*articuli*, that is, "little joints").

We have already said that conjunctions belong in their origin to all the leading parts of speech. Examples of verbs so employed are seen in the English *if*, formerly written *gif*, that is, *give*. (Horne Tooke, as before, p. 103, &c.) The Latin *licet*, "although," is evidently a verb signifying "it is allowed." So too *vel*, "or," appears to be an imperative of *volo*, "choose," but *si* "if," older form *sin*, instead of representing *sit*, as is often said, is of pronominal origin; and indeed akin to our own *so* and *such*, so far as regards the first element of this adjective (*so-lich*, German). The English *while* is a substantive signifying "time." "Either" and "whether" are of course pronominal adjectives, and "or" is a corruption from "other," as is evident from the German equivalent *oder*. And a similar analogy seems to lead to the derivation of the Latin *aut—aut*, from *alterum—alterum*. Conjunctions of a participial and prepositional character have occurred in the examples already quoted; but the relative form appears to be specially fertile in the production of this class of words, as, in the Latin, *quam, quando, quamquam, quamvis, ubi, unde, ut, quia, quod;* and the English *when, how, as, where*.

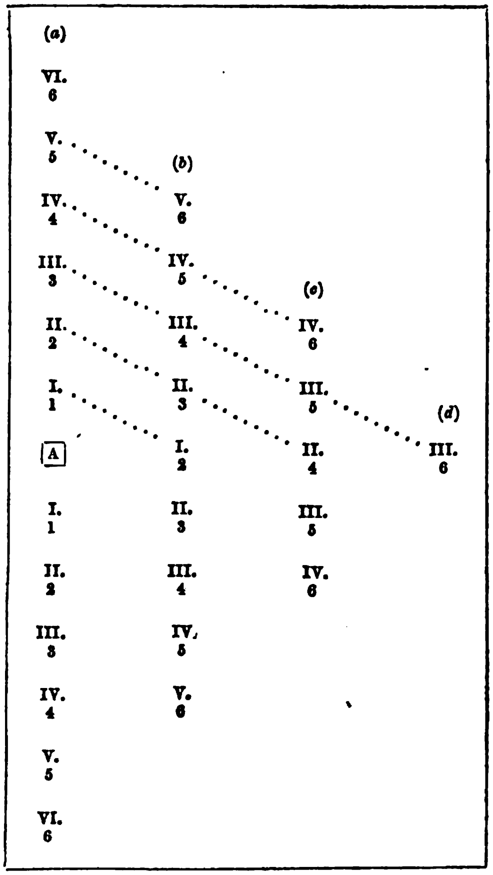
Many of the conjunctions defy all attempts at analysis, and certainly Horne Tooke, notwithstanding the acuteness and truth of his general views, has occasionally erred in the details of derivation.

CONOID (like a cone), a term sometimes applied, but in this country only, to the surface generated by the revolution of a conic section about its axis. [SPHEROID, HYPERBOLOID, PARABOLOID.]

CONSANGUINITY, or KINDRED, in law, is the relation subsisting between persons who are of the same blood, or, in other words, who are descended from the same stock or common ancestor. Consanguinity, in this sense, is either *lineal* or *collateral*. The former subsists between persons who are related to each other in the direct ascending line, as from son to father, grandfather, great-grandfather, &c.; or in the descending line, from great-grandfather to grandfather, father, and son. Collateral kindred are those who, though they have the same blood, derived from a common ancestor, and are therefore *consanguinei*, do not descend one from the other. Thus brothers have the same blood, and are descended from a common ancestor, but they are related to each other collaterally, and the children and descendants of each of them are all collateral kinsmen to each other. The canon law and the civil law have adopted different methods of computing the degrees of collateral consanguinity. According to the former, which has been followed by the law of England, we begin at the common ancestor, and reckon downward to the persons whose degree of consanguinity we desire to ascertain, counting each generation as a degree; and the degree of consanguinity in which they stand to each other is the degree in which both of them, or the more remote of them, stands to the common ancestor. Thus (to use the example given by Sir William Blackstone), Titius and his brother are related in the first degree, for from the father to each of them is counted only one; but Titius and his nephew are related in the second degree, for the nephew is two degrees removed from the common ancestor, namely, his own grandfather, the father of Titius. On the other hand, in this supposed case, the civilians would place Titius and his nephew in the third degree of consanguinity, for they count all the degrees from one given person upwards to the common ancestor, and downwards from that common ancestor, whose degree of relationship to the first person it is the object to establish. Thus they would count from Titius's nephew to his grandfather two degrees, and one more from the grandfather to Titius. By the law of England, all persons related to each other by consanguinity and affinity, nearer than the fourth degree of the civil law, are prohibited from marrying excepting in the ascending or descending line (in which the case is hardly possible by the course of nature); and by Stat 5 & 6 Will. IV., c. 54, sec 2, it is enacted, "that all marriages celebrated after the date of that Act between persons within the prohibited degrees of affinity or consanguinity, shall be absolutely null and void to all intents and purposes whatsoever." Under the statute of distributions, 22 & 23 Car. II., c. 10, in making the distribution of an intestate's personal estate among the next of kin, the computation of degrees of kindred is according to the civil law. ('Novell.,' 118, and INTESTACY; Blackstone's 'Essay on Collateral Consanguinity,' and Blackstone's 'Commentaries,' vol. ii., p. 534; Mr. Kerr's ed.)

The question of consanguinity is the question of relation between two given persons, as explained above. If one of these persons i called $\boxed{\text{A}}$, all his lineal ancestors will be found in (*a*) the ascending line above him, and all his lineal descendants in the descending line below him. His collateral relations will be found in the parallel lines (*b*), (*c*), (*d*), &c. The Roman numerals denote the respective degrees of consanguinity in the canon, and the Arabic those in the civil law. Thus III. in the ascending line is A's great-grandfather, and III. in the descending line his great-grandson. In the ascending and descending lines the computations of the civil and canon laws, as already explained, is the same: in both laws the great-grandfather and great-grandson are respectively in the third degree from A. No. III. in line (*b*) is A's great uncle, who, according to the mode of reckoning already explained, is in the third degree of consanguinity to A by the canon law; and in the fourth, as denoted by the Arabic numeral 4, placed under III., by the civil or Roman law.

The following are the names for consanguinity in the Roman law. In line (*a*), ascending from A: 1, pater, mater; 2, avus, avia; 3, proavus, proavia; 4, abavus, abavia; 5, atavus, atavia; 6, tritavus, tritavia: all above 6 are included in the general name "majores." In



line (*a*), descending from A: 1, filius, filia; 2, nepos, neptis; 3, pronepos, proneptis; 4, abnepos, abneptis; 5, atnepos, atneptis; 6, trinepos-trineptis: all below 6 are included in the general name of "posteri" or "posteriores."

In line (*b*), beginning with 2 and ascending: 2, frater, soror; 3, patruus, amita (uncle and aunt on the father's side); avunculus, matertera (ditto on the mother's); 4, patruus magnus, amita magna, avunculus magnus, matertera magna; 5, propatruus, proamita, proavunculus, promatertera; 6, abpatruus, abamita, abavunculus, abmatertera.

In line (*b*), beginning with 3 and descending, the names are, 3, fratris, sororis, filius et filia, and so on.

In (*c*), beginning with 4 and ascending: 4, consobrinus, consobrina, which are the general terms, but properly signify those born of two sisters (quasi consororini); sons born of two brothers are properly called fratres patrueles; daughters, sorores patrueles: 5, propior or prior sobrino, propior sobrina, the sons and daughters of the patruus magnus, amita magna, &c. (See Tacit. 'Annal.,' xii. 64.)

Some of the Latin writers used "nepos" to express a brother's or sister's son.

It is unnecessary to go farther. ('Institut.,' iii. tit. 6, 'De Grad. Cognationum.')

CONSCIENCE, COURTS OF. All the Courts of Conscience, Courts of Request, and other similar tribunals were abolished in 1846, by the statute 9 & 10 Vict. c. 95, on the creation of the new County Courts. [COUNTY COURTS.]

CONSCRIPTION is the name given to the mode of recruiting the French army. Under the old monarchy the army was recruited chiefly by voluntary enlistment, and the soldiers were taken mostly from the peasantry, by whom the change from the condition of a daily labourer to that of a soldier was considered as an improvement. The officers were appointed from among the higher or educated classes. When the revolution commenced the old army was broken up, the whole nation was called to arms, and volunteers were found in abundance. But as the soldiers were bound by no permanent obligation, a system of requisition was enforced, by which every district was bound to furnish a certain number of men for the regular army. But even this proved insufficient, and the Executive Directory found itself in want of soldiers to supply the numerous armies on the frontiers. In 1798, General Jourdan presented to the Council of Five Hundred a project of a law for a new mode of recruiting, under the name of conscription. This project was approved by the legislature, and passed into a law 5th of September, 1798. After setting down as a principle that every Frenchman is bound to defend his country when in danger, the law went on to say, that independently of danger to the country, every Frenchman from the age of twenty to twenty-five is liable to be called out to serve in the regular army. Every year lists were made in every department of the young men of the age above stated, divided into five classes, the first being those between twenty and twenty-one years; the second from twenty-one to twenty-two; and so forth. The number of men required for that year being made known by the government, and voted by the legislature, a distribution was made among the departments and districts of the quota which each was to furnish. The number required was then taken by lot from the first or junior class, and when that was exhausted from the second, and so on. This operation was repeated every year. The first levy by conscription in 1799 was 200,000 men. Bonaparte, when first consul, found the system already established, and he applied himself strenuously to render it more effective, and carry it to the utmost extent.

By an article of the Charte in 1830, a new law of conscription was provided. This law was promulgated 21st March, 1832, and it declares that the army is be recruited only by voluntary engagements and by the "appel," which term signifies a choice by the drawing of lots amongst the young men of each canton who have completed their twentieth year during the year preceding. The following persons are exempt from the "appel:" any orphan with younger brothers or sisters; an only son or grandson, and the oldest son or grandson of a widow or blind father, or of a father above sixty, but if the eldest son or grandson in either of the last-mentioned cases is blind or infirm, the youngest is exempted. There are also some other exceptions, as persons engaging in public instruction, or who are preparing for the Church or the ministry in any religious denomination which is paid by the state, also students who have obtained certain prizes. There is an appeal to a council of revision for those who conceive that they ought to have been exempted. The period of service is seven years. Persons who have drawn lots which render them liable to serve may obtain a substitute, who must be above twenty and not above thirty years of age, or thirty-five if he has already served in the army, or between eighteen and thirty if the brother of a person liable. Substitutes must not be married, or widowers with children. A person under the age of thirty cannot be admitted to any civil or military office unless he has fulfilled the obligations of the law of 21st March, 1832. Napoleon admitted in principle the procuring of substitutes, and even defended it in the Council of State, as necessary "in the present state of society, which was very different from that of Sparta or Rome;" but he afterwards surrounded it with so many difficulties, that substitutes became extremely scarce and expensive.

In Prussia, all men able to bear arms from twenty to twenty-five belong to the standing army; they serve three years, and are then discharged for two years, during which they are liable to be called out as the reserve. All those who have served in the standing army belong to the landwehr of the first ban, from the age of twenty-six to thirty-two inclusive. This ban, in time of war, is liable to serve abroad as well as at home. It is called out every year to exercise. The second ban is called out only in time of war, and includes all men capable of bearing arms till the age of thirty-nine. All older men fit for service belong to the landsturm. For an account of the Prussian military system, see Laing's 'Notes of a Traveller.' [MILITIA.]

CONSECRATION (*consecratio*), the act of sanctifying or making holy, consists in the solemn appropriation or dedication of anything to the service of the Deity. In modern times the consecration of men is usually called *ordination*, except in the case of kings and bishops, when the performance of the rites of sanctification is still named consecration. When applied to temples, churches, and altars, it is generally termed *dedication*. It is sufficient to advert to the religious antiquities of India, Egypt, Judæa, Chaldæa, Greece, Rome, and of the Celtic Druids in Britain and Europe in general, to show the antiquity of consecration. At the commencement of the Mosaic dispensation all the first-born of man and beast were consecrated to the Lord. (Exodus xiii. 2, 12, 15.) Subsequently the whole tribe of Levi was thus consecrated instead of the first-born (Numbers iii. 12, 45; viii. 16, 18); and Aaron and his sons, who were Levites, were more especially consecrated to the priest's office. (Exodus xl. 13.) The dedication or consecration of the tabernacle and altar is described in the book of Numbers, ch vii. Of the dedication of the first or Solomon's Temple, a description is given in 1 Kings viii. 5; and of the second temple in Ezra vi. 16. Under the Jewish theocracy not only men and beasts were consecrated to the Lord, but houses, fields, and the walls of Jerusalem. (Leviticus xxvii.; Nehemiah xii. 27.) At the commencement of the 4th century, when Christianity, under Constantine, became the established religion of the Roman state, and Christian temples began to vie in magnificence with those of the Pagan deities, they were consecrated with great pomp; for instance, the church of Jerusalem, built by Constantine over the supposed site of the Holy Sepulchre, when the ceremony was performed by a full synod of all the bishops of the East. (Euseb. 'Ecc. Hist.,' l. 10, c. 45; Gratian, 'Concordantia Discordantium,' part 3.)

The following are the principal parts of the rite of consecrating a church according to the Roman Catholic pontifical: Previous to the ceremony three crosses are painted on each wall of the church, and over each cross is placed a lighted candle. The bishop, in his pontifical vestments, proceeds to the church door, attended by his clergy reciting the seven penitential psalms; and after a solemn procession round the external walls, which are copiously sprinkled, in the name of the Trinity, with a kind of brush dipped in consecrated water, the bishop knocks loudly at the door with his pastoral staff, repeating from the 24th Psalm, "Attollite portas, et introibit Rex Gloriæ;" to which a deacon, who is within the church, replies, "Quis est iste Rex Gloriæ?" The bishop responds, "Dominus fortis et potens, Dominus potens in prælio," &c.; then signing the door with the figure of the cross, he exclaims, "Ecce crucis signum! fugiant phantasmata cuncta." On the admission of the bishop and clergy the 'Veni Creator' is chanted, and ashes are strewn on the floor in the form of a cross, in which the bishop, with his staff, traces some alphabetical characters. After several prayers, the altar is consecrated by sprinkling it with a mixture of water, wine, salt, and ashes, in the name of Jesus Christ. The solemnity closes by depositing in the altar a vessel containing relics and incense, with a parchment inscribed with the name of the bishop and the date of the consecration. The church on this occasion is richly decorated, and the altar is illumined with a profusion of large tapers. (Broughton's 'Hist. Dic.,' vol. i., p. 311.) Churches are not recognised as such by the law of England until they are consecrated by a bishop. The form used by the Church of England is given at length in Bishop Gibson's 'Codex juris Ecclesiastici Anglicani,' pp. 1459–1463; see also Bishop Wilkins's 'Concilia Magnæ Britanniæ,' vol. iv., p. 668; and Burn's 'Eccles. Law, Churches,' sec. 2. The present form has been used since 1712; and in 1799 it was adopted, with some slight modification, by the Episcopal Church in America. One of the principal charges on which Archbishop Laud was arraigned before the Commons was, that he endeavoured to revive the Roman Catholic ceremonies in the consecration of churches and altars, with all their costly furniture. Still the Protestant form of consecration, as well as the Roman Catholic, is an imposing ceremony; and the 21 stat. Henry VIII. c. 13, states as the reason for allowing a bishop six chaplains, that this number is requisite for the consecrating of churches. The village feasts which are still celebrated in many parts of England commence on the anniversary day of the consecration of the parish church, and are said to have been substituted by Pope Gregory the Great for similar festivities appertaining to the Druidical religion. (Bingham, b. 8, c. 9.) Church-yards, when, as was usual, they adjoined the church, were consecrated at the same time; but since the establishment of cemeteries they are consecrated separately, and a part is left unconsecrated for the use of dissenters from the Church of England. Deacons and priests are likewise consecrated before entering on their holy office, and the form of their consecration, or ordination, as it is there called, is given in the Prayer Book. Consecration is generally understood to change not the nature of the thing consecrated, but merely the *use* of it; and in this opinion the Roman Catholics appear to acquiesce, with regard to numerous objects which they usually consecrate, as church bells, candles, water, oil, crosses, pictures, &c.; but with respect to the consecration of the eucharistic bread and wine, they maintain that a complete change is effected in the thing consecrated.—the body and the blood of Jesus Christ, by the change of the bread into his body, and of the wine into his blood, being believed to be really present by virtue of the words of consecration. This is what is termed transubstantiation. (Brunet, 'Parallèle des Religions,' 4to, 1792, tome iii., p. 310; 'Exposition de la doctrine de l'Église Catholique,' par Bossuet.)

The consecration of animals was very common in ancient Egypt, where birds, beasts, and reptiles were privileged, as in modern India, to live unmolested, and even to receive adoration. Athenæus and Ælian speak of sacred fishes, adorned with necklaces; so the sacred crocodile in Egypt was decorated with ear-rings. (Herodotus, ii. 69.) Consecration is a name given to the apotheosis of the Roman emperors, and coins and medals commemorating these events have the inscription "Consecratio." See an account of these funeral honours in the article Apotheosis, and the medal with the legend "Consecratio" in the article Aurelius, in Biog. Div.

CONSERVATORS OF THE PEACE, before the comparatively modern institution of justices of the peace, were officers who by the common law of England were appointed for the preservation of the public peace. These conservators, whose powers were far inferior to those of modern justices of the peace, consisting almost entirely of the authority to take sureties for the peace and for good behaviour, were of several kinds. In the first place, certain high functionaries were general conservators by virtue of their offices. Thus the king, the lord chancellor or lord keeper, the judges of the court of King's Bench, and the master of the rolls, were intrusted by the common law with the general conservancy of the peace throughout the realm, as incidental to their several offices. Other officers again were conservators only in special places; thus the judges of the common pleas and barons of the exchequer were conservators of the peace only within the precincts of their several courts. In like manner, judges of assize and gaol-delivery within the places limited by their commissions; coroners and sheriffs within their several counties, and constables and tithingmen within their hundreds or tithings, were all conservators of the peace at common law; and all the officers above enumerated retain their authority at the present day. But besides these official conservators, there were others who were expressly intrusted with the charge of the peace, either by prescription, election, or tenure. Thus it is said that the owner of a manor might have prescribed that he and his ancestors, whose estate he had, were entitled to be conservators of the peace within such manor. So also as sheriffs were formerly elected, and as coroners still are elected, by the freeholders of the county, certain persons were, before the reign of Edward III., elected conservators of the peace in different counties. There were also instances in which lands were granted by the king to hold of him by knight's service, and also by discharging the duties of conservation of the peace within the county where the lands lie. Besides these, there were conservators of the peace appointed by letters patent from the crown, in cases of emergency, to defend particular districts, where breaches of the peace were apprehended in consequence of foreign invasion or intestine tumult. All the different kinds of conservators of the peace above noticed, excepting those who have the duty cast upon them as incidental to other offices, were entirely superseded upon the establishment of the system of justices of the peace in the early part of the reign of Edward III. [Justices of the Peace.] (See also full details upon this subject in Lambard's *Eirenarcha*, book i., cap. 3.)

CONSERVATOR OF THE STAPLE, in the law of Scotland, an officer in the nature of a foreign consul, resident at Campvere, in the Netherlands. See the Act 1503, c. 81. The office has long been obsolete.

CONSERVATORY. The names given to the garden buildings employed for preserving plants in an artificial climate, are applied with so little precision, that it is almost a matter of indifference which to select for the purpose of explaining the principles that ought to be observed in the construction and management of such houses. We shall therefore reserve for the article Green-House what we have to say upon that head, and briefly dismiss the others as their names occur. In illustration of this remark we may observe that the term conservatory, which, as its meaning shows, was originally intended for buildings in which plants were preserved during winter, has come to be used, firstly for glass-houses in which plants are cultivated by growing them in the open border, and subsequently for all such glazed buildings whatsoever. A conservatory, properly so called, is a brick building heated by artificial means, having its whole southern part closed by large glazed sashes, which may be opened or shut at pleasure. Its floor is generally of stone, and a part of it is occupied by a stage on which plants in pots can be placed. One of these buildings, but in a ruinous state, may be seen in the physic garden at Chelsea; others are not uncommon in gardens that were laid out forty or fifty years ago, but they are fast falling into neglect and disuse—in our opinion undeservedly. Such a conservatory was intended to preserve during the winter orange-trees, myrtles, American aloes, and similar plants, which during the summer will flourish in the open air, but which require in winter to be protected against the inclemency, or, to speak more exactly, against the cold and wet of the English climate. Such plants are torpid during winter; their rest begins with that of our trees, and it is easy to prevent a renewal of their growth at too early a time; to preserve them against too much wet and from severe cold, especially in the spring, is all that is requisite for them, and these objects the old conservatory answered perfectly well. It had moreover the advantages of being spacious without being excessively costly; of being easily heated, and of requiring the smallest possible amount of labour for the plants preserved in it. Persons however, gradually forgetting the original object of a conservatory added to it numerous species requiring a very different treatment in winter from those it was contrived for; and what was far worse, they attempted by humidity and high temperature to keep the plants in a growing state through the winter. The necessary consequence of this was, that those plants which formerly succeeded in the conservatory became unhealthy, the new comers disappointed the expectations of their cultivators, and the class of building itself fell into discredit. The reason of this is sufficiently obvious. Plants when in a growing state require an abundant supply of light: a conservatory is particularly ill calculated, on account of its solid roof and sides, for the admission of light, and consequently a conservatory is not suitable for plants in a growing state; but plants when torpid, as in their winter season, require a very moderate supply of light, and this a true conservatory is sufficiently calculated to admit.

A house of this kind is best suited for gardens of considerable extent, where a large number of plants is required during the summer for the ornament of the flower garden and shrubbery. Under such circumstances we strongly recommend the erection of conservatories as the cheapest, the most efficient, and the most ornamental mode of preserving in a healthy state during winter not only oranges, myrtles, and similar plants, but in general all the species which are natives of countries that, without experiencing severe frost, are cold enough during winter to suspend the vital energies of vegetation. It will be perfectly within the gardener's power to keep the earth in which conservatory plants grow sufficiently damp during winter to enable them to accumulate by the return of spring an abundant supply of new sap; and this is all that he need be particularly reminded of, if he understands his business scientifically; if he does not, advice to him would be only a waste of words. [Green-House.]

CONSERVES differ from confections in minor details only. They are formed of flowers, herbs, roots, fruits, and seeds, all recent and fresh, beaten up with powdered sugar to the consistence of a stiff paste,—as a means of preserving the distinctive qualities of the plant in a fresh state. The range of substances thus treated is very extensive.

CONSIDERATION. This is a Latin word, *consideratio*, which, as well as the verb *considero*, was used by Cicero and others to express "careful observation," or "reflection," or "deliberation before action." It has nothing to do with looking at the stars, as the Latin grammarian Festus states; but it implies something which is nearer to the business of common life than star-gazing: it implies the sitting down of a man in a place alone or with others. The word *consideration* means "deliberation" in the English language of common life.

But the term consideration has also a legal and technical meaning independently of its primary and common meaning; namely, the recompense which a party who enters into a contract gets for making, or the motive or inducement which he has to make, the contract in question; and such consideration may be either *express* or *implied*. The following are examples of *express* consideration: If a man agrees to sell his land to another for 100*l.*, the 100*l.* is the consideration for which he, the former, agrees to part with his land; or if a man promises to give 1000*l.* to another if he will marry his daughter, the fact of the latter marrying the daughter is the consideration for the agreement of the former to pay the 1000*l.* But there may be an *implied* consideration in many cases where none is expressed: for example, a man may undertake to do a piece of work for another without any express bargain that he shall be paid; but if he does the work according to his agreement, the other man may be compelled to pay him, because the law implies a promise on his part to pay if the work is done; and the implied consideration for this promise is the undertaking of the workman to do the work in question.

Contracts not under seal cannot be enforced if made without a consideration. A man may promise verbally or in writing to give another 1000*l.*; but the promise cannot be enforced unless there is a consideration for it; that is, some cause or reason which moved the contracting party to enter into the contract. But with regard to contracts under seal, the rule is different; for the law assumes such a contract to have been entered into with due deliberation, and binds the contractor to his engagement, whether he received a consideration for it or not.

Considerations are sometimes divided into *valuable* considerations and *good* considerations. Marriage is a valuable consideration; money, or any other thing which is of the nature of property, and has a common value, is a valuable consideration. If a man parts with his estate for a valuable consideration, the transaction is valid, and he who gets the estate has, so far as the consideration is concerned, a good title. A good consideration, on the other hand, is not sufficient to maintain the validity of a conveyance of property against the claim of a subsequent purchaser for a valuable consideration. Thus, if a man after his marriage settles an estate upon his wife and children in consideration of natural affection, and then sells the estate for money, the purchaser will have the estate, and not the wife and children (Hill *v.* Bishop of

Exeter, 2 Taunt. 69),—such a settlement after marriage being held to be voluntary or gratuitous. But a settlement of property made in consideration of a future marriage, which afterwards takes place, is a settlement for valuable consideration; and so is an actual settlement after marriage, if it is made pursuant to a written agreement entered into before marriage. But the distinction just pointed out between *good* and *valuable* considerations exists only in the case of contracts *under seal*. In the case of contracts *not under seal*, no consideration is good which is not also valuable.

So by the Statute 13 Eliz. c 5, the object of which is to prevent persons from cheating their creditors by disposing of their real or personal property, it is declared that the provisions of the Act do not extend to estates or interests made or conveyed "upon good consideration and *bonâ fide*;" and the term good consideration here has been held to be equivalent to what has been above defined to be a valuable consideration.

The Acts 27 Eliz. c. 4, and 30 Eliz. c. 18, § 3, made void, as against subsequent purchasers, all conveyances, &c., of real property which are made for the purposes of defrauding such purchasers, unless "upon or for good consideration and *bonâ fide*." This statute has received a singular interpretation; for it has been decided that it makes void a previous conveyance, though not made to defraud any one, if the consideration is not such as the statute intends; and accordingly, as in the case just stated, if a man settles his land after marriage on his wife and children, and then sells it, the prior settlement is void as a fraudulent conveyance.

A voluntary conveyance by a man who is at the time insolvent is not valid against his creditors; but if a man is not insolvent at the time, a voluntary conveyance—that is, one where there is no valuable consideration—is valid against future creditors. (13 Eliz. c. 5) A conveyance for valuable consideration, such as marriage, is a valid conveyance, even if a man be insolvent at the time. An insolvent may therefore cheat his creditors by settling his property on a woman with a view to marriage, and then marrying her; but in certain cases, such settlements are not valid against creditors when made by a person who is subject to the bankrupt laws. A voluntary conveyance is not valid against a future purchaser for good consideration: it is a fraudulent transaction according to the construction of the 27th of Eliz.; and as such is declared void against the purchaser. If the purchaser knew that there was such a voluntary prior conveyance, that makes no difference; his purchase is valid against such conveyance.

It appears from these instances that the fact of there being a good consideration may be evidence that there is no fraud; and that the absence of it may raise a presumption of fraud.

Every deed, therefore, or instrument by which property is conveyed to another, ought to show some consideration for which the person conveys such property; for though a deed is valid between the parties to it when no consideration is expressed, it may be invalid with respect to other persons who are not parties to it.

There is no absolute amount of consideration which can be legally required; but if the amount were very small, this might in some cases raise a presumption of fraud; although, even if the amount of consideration should be the full value of the thing conveyed, it might be necessary in some cases to inquire whether the consideration expressed was actually paid.

In the case of a contract or agreement to give or settle property, the necessity for a consideration is obvious, both for the protection of the giver, and of others to whom he is indebted, or whom it is his moral duty to provide for. No such contract can be enforced unless it be made as a sufficient legal consideration. An agreement to settle property on a lawful child may be such consideration; the case of an illegitimate child is not such a consideration. An illegitimate child is viewed as standing to his supposed father exactly in the situation of a stranger.

Many curious legal questions have arisen on the doctrine of consideration, as, for instance, in the case of one man promising to pay the debt of another. But the rule is, that a promise to pay a debt already incurred by another is not binding, unless it be made on some consideration:—for example, the agreement by the creditor to forbear proceedings against the debtor to recover it; or unless such debt was originally incurred at the request of the party making such promise.

Of course any contract made in consideration of the doing of a fraudulent or illegal act, is void.

CONSISTORY is the court christian, or spiritual court, formerly held in the nave of the cathedral church, or in some chapel aisle or portico belonging to it, in which the bishop presided, and had some of his clergy for assessors and assistants. But this court is now held by the bishop's chancellor or commissary, and by archdeacons and their officials, either in the cathedral church or other convenient place in the diocese, for the hearing and determining of matters of ecclesiastical cognisance happening within that diocese.

By stat. 24 Henry VIII. c. 12, an appeal lies from this court to the court of the archbishop of the province; but as proceedings against the beneficed clergy now take place under the Church Discipline Act, 3 & 4 Vict. c. 86, and against curates under stat. 1 & 2 Vict. c. 106, and proceedings against laymen are almost unknown, the functions of the consistory court are rarely called into action.

CONSOLS, a term familiarly used to denote a considerable portion of the public debt of the United Kingdom, more correctly known as the three per cent. consolidated annuities. This portion of the debt originated under an Act 25 Geo. II., whereby various perpetual and lottery annuities then outstanding, and which from the time of their creation had respectively borne an interest of 3 per cent., were brought under one head in the public accounts. Various additions have from time to time been made to the amount of these annuities; and, on the other hand, some diminution has been effected by the operation of the sinking-fund and the application of surplus revenue. The capital outstanding and unredeemed under this head, on the 5th of January, 1859, amounted to 407,202,855*l.*, of which 6,373,044*l.* was on account of the Irish debt. The whole bears an interest of 3 per cent. per annum.

CONSONANCE, in Music, a term which has, we think, often been explained with too strict a regard to its etymological meaning. That it signifies *one sound heard with another* is undeniable, but the two sounds must, in our opinion, be concords. [CONCORD.] *Consonance* and *dissonance* are words which, in music, ought to be considered as synonyms of *concord* and *discord*.

CONSONANT. [ALPHABET.]

CONSPIRACY. Every conspiracy to do an unlawful act which is injurious to individuals or to the public, is a misdemeanor at the common law of England. Many frauds affecting individuals, which cannot be made the subject of prosecution as such, become indictable when they are effected by the co-operation of several confederates. Thus, where several persons agree by indirect means to impoverish a third person, as by circulating calumnies injurious to his character or credit, the offence is punishable as a conspiracy, though the concerted acts alone, when committed by individuals, could only have formed the subject of a civil action by the injured party. Another instance of this is, the case of a conspiracy among journeymen or servants to raise the price of wages, by molesting those who work under a certain price. In former times, persons convicted of conspiracy at the suit of the king (the nature of which offence is very doubtful), were liable to receive what was called *villainous* judgment, by which they were rendered incapable of acting as jurors or witnesses, their lands and goods were forfeited for life, and their bodies committed to prison. This judgment was never however inflicted upon persons convicted of conspiracies of a less aggravated kind at the suit of the party; and in modern times, the villainous judgment having become obsolete by long disuse, the punishment of conspiracy has been by fine, imprisonment, and sureties for good behaviour, at the discretion of the court. (Russell *on Crimes and Misdemeanors*, vol. ii.)

CONSTABLE. This word is supposed by Ducange, Spelman, Cowell, and other legal etymologists, to be corrupted from *comes stabuli*, which was another name for the *tribunus stabuli* or *prepositus equorum*, a kind of master of the horse, frequently mentioned as an officer of state in the middle ages. (See Ducange's 'Glossary,' *ad vocem* 'Comes Stabuli.') Sir Edward Coke, Selden, and several other writers, insist upon another etymology—from two Saxon words, *koning*, a king, and *stapel* or *stabel*, a stay or support—*quasi columen regis*. Both these derivations are equally remote from the description of the office of our modern constable; but the former appears to be far the more probable; and in accordance with it, the constable of France was an important officer of the highest rank in that country, who had the chief command of the army, and had judicial cognisance of military offences; and whose duty it was to regulate all matters of chivalry, such as tilts, tournaments, and feats of arms. This office was suppressed in France by an edict in the year 1607; it was revived by Napoleon, and constituted one of the six grand dignities under the French empire; and was finally abolished upon the restoration of the Bourbon dynasty in 1814.

Immediately after the Norman conquest, we find in England an officer of the crown called the Lord High Constable, whose duties, powers, and jurisdiction were in most respects strictly analogous to those of the constable of France. The office was one of great dignity and power, both in war and peace, the constable having the command of the army and the regulation of all military affairs. He was the supreme judge of the court of chivalry, in which character his encroachments upon other courts were so heavy a grievance in early times, that the stat. 13 Rich. II. c. 2, was passed to restrict his jurisdiction to "contracts and deeds of arms and things which touch war, and which cannot be discussed or determined by the common law." The office for several centuries after the Conquest, passed by inheritance in the line of the Bohuns, Earls of Hereford and Essex, and afterwards in the line of their heirs-general, the Staffords, Dukes of Buckingham, in right of certain manors held by them by the feudal service of being constables of England. The fees of the office were extremely burdensome to the crown; and the possession by a subject of the hereditary right to command the militia of the realm, independently of any royal appointment, was an unusual and frequently a dangerous power; and on this account Henry VIII., in the early part of his reign (1514), consulted the judges respecting the means of abolishing the tenure. He was advised by them, that as the individuals holding the manors were only compellable to exercise the office *ad voluntatem regis*, he had the power of discharging the feudal service altogether; and acting upon this opinion, the king abolished the office, by disclaiming to have the services any longer executed. (See Dyer's 'Reports,' p. 282 b.) The effect of this was, that Edward Stafford, the last Duke of Buckingham in that line, the hereditary high constable of England at the time of this resolution, held the manors after this period discharged of the service of being constable. All doubt which might have been suggested respecting the legal extinction of the office by this means, was removed eight years afterwards by the attainder of the Duke of Buckingham for high treason, upon which event the manors in question were forfeited to the crown. Since that time, the office of high constable has never been granted to any subject excepting *pro hâc vice*, upon great and solemn occasions, such as the king's coronation or trials of peers.

"Out of this high office," says Lambard, in his 'Duties of Constables,' "the lower constableship was first drawn and fetched, and is (as it were) a verie finger of that hand; for the statute of Winchester, which was made in the time of Edward I., and by which the lower constables of hundreds and franchises were first ordained, doth, among other things, appoint that, for the better keeping of the peace, two constables in every hundred and franchise should make the view of armour." He then concludes, in justification of his etymology of the term, that "the name of a constable in a hundred or franchise doth mean that he is an officer that supporteth the king's majesty in the maintenance of his peace." This derivation of the office of a common constable seems very improbable, especially as it is the better opinion that these officers were known to the common law before the statute of Winchester. (See Hawkins's 'Pleas of the Crown, book ii. cap. 10.) An ancient judicial authority, chief justice Fineux, in the reign of Henry VII., gives a more reasonable account of the matter. He says that when the superintendence of the peace of a county was found too great a task for the sheriff, hundreds were formed, and a conservator of the peace under the sheriff appointed in each, who was called a constable. This was the high constable, or constable of the hundred. In process of time, as population increased and towns grew into existence, it was found expedient to make a further subdivision for the preservation of the peace; and accordingly, conservators were appointed for manors, vills, and tithings, who were then called petty constables. (See 'Year Book,' 12 Henry VII., pl. 18.)

Following this account of their origin, which is confirmed by many of the minute incidents of the two offices, constables, in the usual acceptation of the term at the present day, are of two kinds; constables of hundreds, who are still called high constables, and constables of vills or tithings, who are called either petty constables or tithingmen. Both high and petty constables were formerly chosen by the jury at the court leet, and were sworn in and admitted there by the lord or his steward; but afterwards the high constables were usually chosen by the magistrates at the quarter-sessions, and now, under the 7 & 8 Vict. c. 33, by the justices at special sessions of the division held for hearing appeals from the parish rates.

The petty or parish constables who had been from ancient times appointed to their office yearly by the court leet, are now, by virtue of the 5 & 6 Vict., c. 109, amended by the 7 & 8 Vict., c. 52, and the 13 Vict., c. 20, appointed by the justices at special sessions held for the purpose yearly, between the 24th of March and the 9th of April, from lists prepared by the overseers of each parish, of persons qualified to serve; but the choice of the justices is not restricted to such lists, and their appointment is valid if it be of a person duly qualified, though his name is not on the overseers' list. The qualification includes every "able bodied man resident within the parish, between the ages of 25 and 55 years, rated to the relief of the poor, or to the county rate, on any tenements of the nett yearly value of 4*l.* or upwards;" but this is subject to a very numerous list of exemptions given in the act, and also to the disqualification of all licensed victuallers, and persons licensed to deal in any exciseable liquor, or to sell beer by retail, or gamekeepers, and all persons who have been attainted of any treason or felony, or convicted of any infamous crime.

But the insufficiency of the ancient means of police coming to be increasingly felt, as modern society advanced in civilisation, Sir Robert Peel, when Secretary of State for the Home Department, in 1829, was enabled by parliament under the 10 Geo. IV., c. 44, amended by the 2 & 3 Vict., c. 47, to establish the metropolitan police force, under the regulation of two salaried justices or commissioners, to whom is entrusted, subject to the approbation of the Secretary of State, the appointment, control, and regulation of the police of the metropolitan district. This was followed by the Municipal Corporations Act (5 & 6 Will. IV., c. 76), which provided, sec. 76, for the appointment of constables by the Watch Committee, to keep the peace within the cities and boroughs of England and Wales. Many large towns and cities, including the city of London, have their police appointed and regulated under local statutes, obtained for the purpose, and many others have availed themselves of the general powers contained in the Town Police Clauses Act, 1847, the 10 & 11 Vict., c. 89. As the same sense of insecurity gradually expanded into the rural districts of the country, provision came to be made by the 2 & 3 Vict. c. 93, and the 3 & 4 Vict., c 88, for the appointment of additional constables for counties or districts of counties, in accordance with the report of justices in quarter sessions, or sessions of the liberty, to the Secretary of State, respecting the necessity and number of such constables in the district or county. But this power was used so sparingly by the country justices, and burglaries and crimes with violence became so frequent in the neglected districts, that parliament, by the 19 & 20 Vict., c. 69, made it compulsory on the justices at the general or quarter sessions, next after the 1st of December, 1856, to establish a sufficient police force in every county or residue of a county, where no such sufficient force existed when the statute was made. The statute provides for annual returns connected with the state of crime in the country, and for a contribution from the consolidated fund, of one-fourth of the expense for pay and clothing of the police of counties and boroughs, established under that or the two previous acts already mentioned, if such force is approved as efficient by the Secretary of State.

Besides the constables and police already mentioned, two or more justices of the peace, upon information that disturbances exist or are apprehended, are authorised by the 1 & 2 Will. IV., c. 41, amended by the 5 & 6 Will. IV , c. 43, to appoint special constables; and by the 83rd section of the Municipal Reform Act, magistrates in boroughs are authorised to swear in as many inhabitants as they think fit, to act as special constables when called upon.

With regard to the powers and duties of these officers, it is enacted by the Metropolitan Police Act and the Municipal Reform Act that the constables to be appointed under those statutes respectively "shall have all such powers and privileges, and be liable to all such duties and responsibilities, as any constable has within his constablewick by virtue of the common law of this realm;" and hence it becomes of great practical importance to ascertain with precision the common-law incidents of the office of constable.

1. By the common law constables are said to have been conservators of the peace; and in consequence of this character probably every constable has undoubted authority to arrest all persons who commit an affray, assault, or breach of the peace *in his presence*, and keep them in safe custody until they can be brought before a magistrate. It is said also by ancient authorities, that by virtue of his power as a conservator of the peace, he may himself, on view of a breach of the peace, take surety of the peace by *bond*, though he cannot do so by recognisance, being incompetent to administer an oath. But as his duty is to preserve the peace, and not to punish for the breach of it, it is doubtful whether he can arrest by his own authority and without a warrant, upon the information or charge of a third person, for an affray committed in his absence. (See the case of 'Timothy *v.* Simpson,' 1 Crompton, Meeson, and Roscoe's 'Reports,' p. 760.) By sect. 9 of the Metropolis Police Act, and by sect. 79 of the Municipal Corporation Reform Act, and sect. 8 of the Rural Police Act, the 2 & 3 Vict. c. 93, constables appointed under those Acts are expressly authorised, in charges of petty misdemeanour in the night-time, to take bail by recognisance for the appearance of the offender before a magistrate within a limited time.

2. A constable having reasonable cause to suspect that a felony has been committed, may arrest and detain the supposed offender until he can be brought before a magistrate to have his conduct investigated; and he will be justified in so doing, even though it should afterwards appear that in fact no felony was committed. In this case there is a distinction between the authority of a constable and that of a private person; the former may arrest if he can show a reasonable ground of suspicion that a felony has been committed; but a private person, in order to justify himself for causing the imprisonment of another, must prove, in addition to the reasonable suspicion of the individual, that a felony has actually been committed. A constable is bound to arrest any person whom he sees committing a felony, or any person whom another positively charges with having committed a felony; but, generally speaking, he has no authority to arrest for a misdemeanour, either upon his own reasonable suspicion or the charge of another person, without a magistrate's warrant. With respect to the authority of a constable to arrest for felony or breach of the peace, Mr. Justice Buller is reported to have said, that "if a peace-officer, of his own head, takes a person into custody on suspicion, he must prove that such a crime was committed; but if he receives a person into custody on a charge preferred by another of felony or breach of the peace, then he is to be considered as a mere conduit; and if no felony or breach of the peace was committed, the person who preferred the charge alone is answerable" Lord Ellenborough (in the case of 'Hobbs *v.* Branscomb,' 3 Campbell's 'Reports,' 420), said that "this rule appeared to be reasonable."

3. Constables were authorised by the common law to arrest such "strange persons as do walk abroad in the night-season." (See Lambard, 'Constable,' p. 12.) This authority, which was perhaps sufficiently definite in times when the curfew was in practice and watch and ward were being kept, is at the present day of so vague a nature, that a peace-officer could scarcely act under it without imminent danger of an action in every particular instance. It is, however, obviously essential to the efficiency of any system of police, that constables should be armed with some general authority of this nature, especially in towns. By the 7th section of the Metropolitan Police Act, it is provided that "any man belonging to the police force appointed under that Act may apprehend all loose, idle, and disorderly persons whom he shall find disturbing the public peace, or whom he shall have just cause to suspect of any evil designs, and all persons whom he shall find between sunset and the hour of eight in the forenoon lying in any highway, yard, or other place, or loitering therein, and not giving a satisfactory account of themselves, and deliver them to the constable in attendance at the nearest watch-house, to be secured until

they can be brought before a magistrate." The Municipal Corporations Act contains a similar but less comprehensive provision, authorising "any constable appointed under that Act, while on duty, to apprehend all idle and disorderly persons within the borough whom he shall find disturbing the public peace, or whom he shall have just cause to suspect of intention to commit a felony." Besides these specific authorities, however, which apply only to the metropolitan police district and the boroughs affected by the Municipal Corporations Act, there is no doubt that in general a constable, by virtue of his common-law authority, may stop any person carrying by night a bundle or goods under circumstances of reasonable suspicion; and if, upon examining him, his suspicions are not removed, he may detain him in his custody. A constable has also a general authority to apprehend for offences against the Vagrant Act, 4 & 5 Geo. IV., c. 83, or against the Larceny Act or the Malicious Injuries Act, 7 & 8 Geo. IV., c. 29 and 30.

4 In the execution of a warrant a constable acts no longer as a conservator of the peace, but as a ministerial officer to the magistrate who signs it. He is the proper officer to a justice of the peace, and is bound by law to execute his warrants, and may be indicted for disobeying them. It is his duty to execute the warrant of a magistrate as soon as it comes to his hands; and where he arrests or distrains, or does any other act within his precinct, though it is not absolutely necessary by law that he should show his warrant, he ought always to give notice of it, and he will be wise to produce it in all cases where it is demanded. If, however, he act out of his precinct, or be not sworn and commonly known, he must show his warrant if demanded; but as the warrant constitutes his justification, he is not required to part with it out of his possession. If the constable has a legal warrant to arrest for felony, or even breach of the peace, he may break open doors after having demanded admittance and given notice of his warrant; and if, after such notice, he is resisted and killed, it will be murder If a warrant be directed to a constable by his name of office merely, he is *authorised* by the 5 Geo. IV., c. 18, to the same extent as when the warrant is addressed to him by his own personal name, to execute it out of his own constablewick, provided it be within the jurisdiction of the magistrate who signs it; but he is not *bound* to do so, and may in all cases make his election whether he will go beyond his own precincts or not.

5. The law has made several provisions for the indemnity and protection of constables in the proper discharge of their duty. Thus by the Stat. 7 Jac. I., c. 5, if an action be brought against a constable for anything done by virtue of his office, he may plead the general issue and give the special matter in evidence; and if he recovers, he is entitled, by the 5 & 6 Vict., c. 97, to full costs. Formerly if a magistrate granted a warrant in a matter over which he had no jurisdiction, the officer who executed it was liable to an action of trespass for so doing; but by the 24 Geo. II., c. 44, s. 6, it is enacted that no action shall be brought against any constable for anything done in obedience to the warrant of a justice of the peace, unless he has neglected or refused to show his warrant on being required so to do. And if, after he has shown his warrant, any action is brought against the constable alone, without joining the justice who signed the warrant, the defendant, on producing the warrant at the trial, is entitled to a verdict, notwithstanding the defect of the justice's jurisdiction; and if the action be brought against the constable jointly with the justice, the constable is entitled to a verdict on proof of the warrant. By the 8th sect of the same statute, all actions against constables for anything done in the execution of their office must be brought within six months. For the further protection of constables, the stat. 9 Geo. IV. c. 31, s. 25, enacts that persons convicted of assaults upon peace-officers in the due execution of their duty may be imprisoned with hard labour for two years, and be fined or required to find sureties for keeping the peace.

For the guidance of the metropolitan police force, the commissioners deliver to each of the men printed directions, which contain an accurate and perspicuous summary of the laws relating to the duties, liabilities, and indemnities of constables. In those boroughs which have adopted a new system of police under the Municipal Corporations Act, similar codes of instruction have been issued to the constables. (For fuller information upon the whole of this subject, see Viner's 'Abridgment,' Bacon's 'Abridgment,' Burn's 'Justice,' title 'Constable,' and Blackstone's 'Commentaries,' by R. M. Kerr, LL D., vol. i.)

CONSTABLE, LORD HIGH, OF SCOTLAND. In the 12th century we find the office in possession of Hugh de Morvill, of the family of the De Morvilles, barons of Burgh, co. Cumberland, contemporary with one Edward, Conestabulus; himself constable of Scotland, and the possessor of vast estates in Teviotdale, Lauderdale, Lothian, Clydesdale, and Cuninghame. He died in 1162, and the office was enjoyed by his descendants till it came to John Comyn, earl of Buchan, who was deprived of it in the year 1308 for his adherence to the Baliol interest. Sir Gilbert de Hay, of Errol, was then made constable of Scotland during pleasure; and in 1311 the office was bestowed on David de Strathbogie, earl of Athol, in like manner during pleasure; but he being soon afterwards outlawed for espousing the cause of Baliol, Sir Gilbert de Hay, before mentioned. got the office in fee and heritage in the year 1314; since which time the constable's staff. then put into his hands by Bruce, has remained in the Errol family.

The office and jurisdiction of the lord high constable of Scotland differ from those of the like officer in England. No formal distribution of the powers of the lord justiciar of Scotland, such as took place at the breaking up of the aula regis of England, was ever made in the former kingdom; nor when in the course of years this happened, did the once large powers of the justiciar pass to the like officers in the one country as in the other. On the new modelling of the judicial polity of England by King Edward I., the constable and mareschal were set over a court of chivalry, with jurisdiction in matters of honour and arms. But in these, the constable of Scotland never had jurisdiction. His jurisdiction was of the nature of that in England, vested by 33 Henry VIII. c. 12, in the lord steward of the king's household, or (in his absence) of the treasurer, comptroller, and steward of the marshalsea; for according to the Leges Malc. II., he judged jointly with the mareschal in all transgressions committed within certain limits of the king's court. But even this jurisdiction seems to have been exercised in fact by the lord justiciar; the constable only protesting against the interference with his powers. In the reign of King Charles I. a commission was issued to inquire into the nature and extent of the constable's jurisdiction; and they reported that it extended to all slaughters and riots committed within four miles of the king's person, or of the parliament or privy council. No alteration was made at the Union; and by the act 20 Geo. II. c 43—which swept away so many other heritable jurisdictions—the office and jurisdiction of the lord high constable of Scotland were expressly reserved.

CONSTANCE, COUNCIL OF. [COUNCILS OF THE CHURCH.]

CONSTANT, a quantity which remains the same throughout a problem. Thus in the question, required that point of a circle which is at a given distance from a given straight line, the radius of the circle is a constant. If the problem require the use of twenty different points of the circle, the radius is the same for all.

A constant may be determinate, or it may be indeterminate or arbitrary. Thus the proportion between the circumference and diameter of a circle is a determinate constant, being 355 to 113 very nearly; but in the problem, required the relation which exists between the abscissa and ordinate of a circle, the radius of that circle is an arbitrary constant.

The term constant is frequently applied to any remarkable or very necessary number which enters a question, as follows: By the *constant* of aberration is meant that one constant by the determination of which the aberration is obtained from its known laws at any given time; in this case it is the maximum aberration, or about 20½". [ABERRATION.] Thus we have the constant of nutation, the constant of friction, &c.

Nothing is more common in mathematical works than the term *variation of constants*, which appears a contradiction. But its meaning is as follows: A quantity which upon one supposition would remain constant, becomes variable by the introduction of another supposition. Thus, taking into account the earth's attraction only, the longitude of the moon's node is constant; but by the attraction of the sun and planets, its place is slowly changed. In this case one of the constants is said to vary.

CONSTELLATION (a putting together of stars), the name of one of those groups of stars into which the whole heavens are divided, and to each of which is imagined to belong the figure of a man, an animal, or some other object, natural or artificial.

The history of the constellations is a matter of mythological antiquity, the most curious features of which are connected with the twelve signs or constellations of the ZODIAC, or the sun's apparent yearly track. It is sufficient for us here to say, that it is certain we derive our constellations for the most part from the Greeks, and that it is nearly as certain that they derived them from the East, though it is highly probable that they altered the legends to suit their own mythology, and in some instances even the figures. Their firmament, if it confined itself to recording the vast and striking events of their mythic system, as in Argo or Hercules, might bear an external presumption of originality, which it wants altogether while so prominent a constellation as the Great Bear represents nothing but the unimportant and irrelevant story of Callisto. But while we are just in possession of sufficient knowledge to deny the original formation of the constellations to the Greeks, and perhaps even to the Egyptians, we have not enough to say in what nation they were first constructed.

The method of figuring the constellations, though in many instances it gives groups which are striking to the naked eye, is one of the worst which could have been invented for the modern purposes of astronomy. A dragon winding round three-quarters of the globe, and a man extending his arms and legs between half a dozen other figures, cannot connect their included stars in any manner which will lead to useful combinations. So that in our modern catalogues, though λ Draconis and ζ Draconis are said to be in the same constellation, the connection is purely one of names, and suggests no ideas of relative position. There are even instances in which stars bearing the name of one constellation are situated in another.

We shall proceed to describe the methods by which the stars in a constellation are distinguished, and the plan we have adopted in the present work. The letters of Bayer are generally adopted for all the stars in his maps. The stars were ranged by him in order of brilliancy, as they appeared to the naked eye, about the year 1600 The Greek letters were first used, and afterwards the Italic small letters. Thus, *a* is the most brilliant star in a constellation according to Bayer while *p*, *q*, &c.,

are comparatively faint. Other astronomers have since carried on the lettering of Bayer, and we have latterly (in this work) distinguished the letters added since Bayer's time by parentheses in all those constellations which were partly lettered by Bayer and partly by others. But in all cases the extent of Bayer's letters may be ascertained by reference to the article in the BIOG. DIV. headed by his name. The letters had been adopted, however, previously to Bayer. [PICCOLOMINI, in BIOG. DIV.]

The next step in the arrangement was that of Flamsteed, who retained the old method of describing stars by their situation in the figure of the constellation (as in the leg, in the head, &c.), but placed the stars of each constellation in order of right ascension, or in the order in which they come on the meridian. Succeeding astronomers described each star by the number which it stood from the beginning in the constellation, and called it Flamsteed's number. Thus 7 Draconis means that star of Draco which comes on the meridian the seventh of all the stars observed by Flamsteed in that constellation. Mr. Baily, in his new edition of the British Catalogue, introduced new stars from Flamsteed's papers, but has allowed them to stand without disturbing the established numbering, and they are easily identified by the general numbering of the new catalogue. Thus, there is a star in Capricornus between 12 Capr. and 13 Capr., which may be described as 2786 of Mr. Baily's edition, that is, the 2786th from the equinox of 1690 of *all* the stars observed by Flamsteed, both of those which are in the 'British Catalogue' of A.D. 1725, and those which have been since drawn from Flamsteed's papers.

The numbering of Piazzi is on a different and inferior principle. The whole heavens being divided into twenty-four hours of right ascension, the stars are numbered in their respective hours of right ascension. For instance, (303) Can. Maj. is, according to Piazzi, a star in Canis Major, not the 303rd of that constellation, but the 303rd of the hour of right ascension in which it fell in the year 1800, counting the first star of the catalogue which passed after the sidereal clock had marked the hour as 1, the second star as 2, &c., and affixing to each the name of the constellation in which it is. If the equinox were fixed, this method would be a good first correction of the vagaries of the constellations; but as it is, some stars which were in one hour of right ascension when Piazzi formed his catalogue are now in another, such as 12 Cancri, 15 Argus, &c., which were in 1830 on the borders of the 7-8 hour of right ascension.

In most other catalogues, such as those of Bradley, Lacaille, Mayer, Fallows, &c., the stars are usually numbered in their order from the beginning of the catalogue, the order being that of right ascension.

The recognised makers of constellations are Aratus, Ptolemy, Bayer, Hevelius, and Lacaille. But Tycho Brahé, Lemonnier, and Poczobut have each added one constellation in the following list, and Halley two. The names without any letter are all in Aratus. (Remember, however, that Libra is only the *claws* of the Scorpion, both in Aratus and Ptolemy) [LIBRA.] Three additional ones in Ptolemy's Catalogue are denoted by P.: Bayer's by B.; Hevelius's by H.; Lacaille's by L.; Tycho Brahé's by T.; Halley's by Ha.; Lemonnier's by Le.; and Poczobut's by Po.

Andromeda.
Antlia Pneumatica, L.
Apparatus Sculptoris, L.
Apus,[*] B.
Aquarius.
Aquila.
Ara.
Argo.
Aries.
Auriga.
Bootes.
Cœlum Scalptoris, L.
Camelopardalis, H.
Cancer.
Canes Venatici, H.
Canis Major.
Canis Minor, P.
Capricornus.
Cassiopeia.
Centaurus.
Cepheus.
Cetus.
Chamæleon, B.
Circinus, L.
Clypeus Sobieski, H.
Columba, Ha.
Coma Berenices, T.
Corona Australis, P.
Corona Borealis.
Corvus.
Crux, Ha, or by Royer, from Halley's observations.
Cygnus.
Delphinus.
Dorado, B.
Draco.
Equuleus, P.
Equuleus Pictoris, L.
Eridanus.
Fornax, L.
Gemini.
Grus, B.
Hercules.
Horologium, L.
Hydra.
Hydra et Crater.[†]
Hydrus, B.
Indus, B.
Lacerta, H.
Leo.
Leo Minor, H.
Lepus.
Libra.
Lupus.
Lynx, H.
Lyra.
Microscopium, L.
Monoceros, H.
Musca,[‡] B.
Norma, L.
Octans, L.
Ophiuchus.
Orion.
Pavo, B.
Pegasus.
Perseus.
Phenix, B.
Pisces.
Piscis Australis.
Piscis Volans, B.
Pixis Nautica, L.
Reticulus, L.
Sagitta.[§]
Sagittarius.
Scorpius.
Serpens.
Sextans, H.
Solitarius, Le.
Taurus.
Taurus Poniatowski, Po.
Telescopium, L.
Triangula [‖]
Triangulum Australe, B.
Tucan, B.
Ursa Major.
Ursa Minor.
Virgo.
Vulpecula (et Anser), H.

There are many other constellations formed by different individuals; but these are not now generally admitted. Such are the Antinous of Tycho Brahé; the Mons Mænalus and Cerberus of Hevelius; the Oak of Charles II. and the Cor Caroli of Halley; the Table Mountain and the Nubecula Major and Minor of Lacaille (the latter being not clusters of distinct stars, but large nebulæ); the Reindeer of Lemonnier; the Reaper of Lalande; the Honours of Frederic, the Sceptre of Brandenburgh, Herschel's Telescope, the Balloon, the Mural Quadrant, the Cat, and the Log Line of Bode; and George's Harp of Hell. Many others, we believe, have been proposed, but there would be little use in reviving their names. In fact, half a century ago, no astronomer seemed comfortable in his position till he had ornamented some little cluster of stars of his own picking with a name of his own making.

In the large maps of the stars, published by the Society for the Diffusion of Useful Knowledge, the constellations are figured precisely as described by Ptolemy, and the additional ones are not drawn, which will therefore render them useful to the readers of Greek astronomical works.

CONSTIPATION, an undue retention or an imperfect evacuation of the fæces. The alimentary canal, considered physiologically, may be divided into two portions; one appropriated to the conversion of the aliment into nutriment, and the other appropriated, among other functions, to the separation and discharge of the refuse matter of the aliment. The first constitutes the apparatus of digestion, and the second that of fæcation. Independently of the organs appropriated to the performance of the preparatory operations of prehension, mastication, insalivation, and deglutition, the apparatus proper to digestion consists of the stomach, the duodenum or the second stomach, the jejunum, and the ileum, the three latter portions of the alimentary canal forming the small intestines. It is in these great digestive chambers that the processes of chymification and chylification are performed; processes by which the multifarious substances taken as food are converted into an homogeneous substance analogous in its composition to the blood. The requisite changes on the food are effected partly by secretions formed by the walls of the digestive chambers themselves, and partly by secretions elaborated by distinct organs and conveyed into the digestive chambers by separate tubes. These auxiliary organs are the pancreas and the liver, the fluids secreted by which perform a most important part in the function of digestion. The chyle, the ultimate result of the action of these digestive fluids, is absorbed, as it is formed, by a set of vessels termed the lacteals, spread out upon the walls more especially of the jejunum and ileum, upon the surface of which they take their origin by open mouths.

But a considerable portion of the substances taken as food is incapable of being converted into chyle; this is separated from the chyle partly in the duodenum, and still more perfectly in the jejunum and ileum, as it flows over the walls of these extended chambers. Moreover, a considerable portion of the digestive fluids themselves does not enter into the composition of the chyle, but is separated from it and mixed with the refuse matter of the food. Again, the whole extent of the alimentary canal, from its commencement to its termination, is lined with a membrane which secretes a peculiar fluid, termed mucus. This fluid which defends the delicate and sensitive vessels that are crowded on every point of the digestive chambers, and which maintains those chambers in a state of suppleness and moisture, is constantly formed, removed, and renewed. That portion of it which has served its office, and which has become effete, is mixed with the refuse matter of the aliment and of the digestive fluids. All these substances mixed together in a common mass are transmitted to the second portion of the alimentary canal, which consists of the large intestines; namely, the cæcum, the colon, and the rectum, by the operation of which the second part of the digestive function, that termed fæcation, is performed. This function consists of two processes; first, of that by which the common mass of excrementitious substances is brought into a state fit for its discharge from the body; and secondly of that by which a force is generated adequate to effect its discharge. The chief agent by which these substances are brought into a state fit for their discharge is the bile. [BILE; in NAT. HIST. DIV.] The agent by which their actual discharge is effected is the muscular coat of the intestines, which is excited to contraction, and thereby to the generation of the force requisite to the accomplishment of the object, by the stimulus of the bile.

It is obvious, then, that the matters to be discharged from the alimentary canal do not consist, as is vulgarly supposed, merely of the refuse portion of the food: this constitutes only a small part of those matters; an essential part of it consists of the refuse matter of secretions which have performed most important offices in the economy.

There is manifest in the performance of certain functions of the body a tendency to periodicity. The most remarkable of these are the return, at regular periods, of the necessity for sleep, of the appetite for food, and of the command to remove from the body the excrementitious matters prepared in the alimentary canal. Whatever may have first led to the formation of these habits, and however they may be varied by circumstances which operate at an early period of life, they cannot, after having been once formed, be materially and frequently interrupted without danger to the health. The interruption of one of these habits by the retention of the fæces beyond a determinate period, namely, the period of twenty-four hours, constitutes the disease termed constipation; a disease often disregarded, generally considered of little importance, always productive of mischief, and very frequently terminating in a fatal result.

---

[*] The Avis Indica of Bayer. [Correct *Apis* Indica in BAYER, BIOG. DIV.]

[†] Crater is a separate constellation in Ptolemy. The neighbouring stars on the body of Hydra were considered by Flamsteed as part of this constellation.

[‡] This is the Apis of Bayer, called Musca by Lacaille; there is, however, a constellation Musca, formed by Bode, we believe, and situated close to Aries, the stars of which are usually considered as belonging to Aries.

[§] A part of Aquila in Aratus.

[‖] Only one in Aratus and Ptolemy. Another added by Hevelius.

The slighter degrees of constipation, when, as is sometimes the case, they are attended with no appreciable disturbance of any function, can scarcely be considered as morbid; but, in general, a retention of the fæces beyond the period of twenty-four hours, is attended with manifest disorder. This disorder is commonly increased in proportion as the retention is protracted beyond that determinate period, and in proportion to the frequency with which such retention recurs. The amount of the disorder thus induced is, however, a good deal influenced by constitutional peculiarity; for there are individuals whose fæcal evacuations are not more frequent than once a week, or once a fortnight, or even once in three weeks. Such an habitual retention of the fæces, in the few cases in which it occurs, generally happens in females who lead a sedentary life, and who take little food and less exercise.

The immediate effects of constipation, when this disease occurs in its usual degree, in ordinary habits, is the production of some one or more of those painful states, the signs of which are generally grouped together under the common name of dyspepsia. There is disordered appetite, which is either deficient, capricious, or voracious; a dry, coated, or clammy tongue; thirst, or some disagreeable taste in the mouth; dulness, heaviness, confusion, giddiness, or pain in the head; physical and mental torpor; dry and hot skin; and last, though not least, an irritable temper, and a capricious or a desponding mind.

The remote effects of constipation are far more numerous and serious than is commonly understood. It is impossible to enter into a full detail of them in this place. But among the most obvious may be mentioned, the origin of various diseases of the skin.

Moreover, headache and giddiness existing as severe and permanent affections, and the distinct diseases called colic [COLIC], chorea [CHOREA], epilepsy, chlorosis, hysteria, hæmorrhoids, and many others, have their most frequent origin in an habitual and protracted retention of the fæces.

The usual termination of constipation when severe, frequent, and obstinate, is in inflammation of the intestines, which commonly assumes the form either of ilius [ILIUS] or enteritis [ENTERITIS], and which rapidly proves fatal.

There is, without doubt, a greater tendency to constipation in some temperaments than in others; in the melancholic, for example, than in the sanguineous, and in certain individual peculiarities of constitution. But this tendency would appear to be capable of being superinduced by the habitual use of certain kinds of indigestible food; such as imperfectly fermented bread, heavy pastry, as dumplings, &c.; indigestible vegetables, as cucumbers, melons, &c. The tendency thus superinduced may be greatly increased by the use of astringent and stimulating beverages, sedentary habits, long indulgence in sleep, &c. The immediate causes of constipation are: 1. an impaired or torpid action of the liver, in consequence of which there is either a deficient or a vitiated secretion of bile. It has been stated that one portion of the bile [BILE, NAT. HIST. DIV.] mixes as an essential constituent with the chyle, by which the nutritive part of the food is assimilated to the constitution of the blood; the other portion of the bile consists of excrementitious matter, principally of a resinous nature. It is this resinous portion of the bile that constitutes the proper stimulus to the colon and rectum, whose office it is, by the contraction of the fibres which form their muscular coat, to remove the fæcal matters from the body. A certain change in the quantity or quality of the bile must therefore necessarily diminish the action of these organs, by depriving them of the stimulus on which their action mainly depends. 2. Torpor of the muscular coat of the alimentary canal itself, and more especially of that portion of it which constitutes the large intestines. 3. The production and accumulation of flatus in these organs, by which their thin parietes are distended, and even a mechanical obstacle is afforded to the passage of the fæces.

The treatment of constipation should always have in view two objects: 1. The immediate removal of the impacted fæces; and 2. The change of the pathological condition of the system in general, or of the alimentary canal in particular, on which the fæcal retention depends.

CONSTITUTION, a term often used by persons at the present day without any precise notion of what it means. Such a definition of a constitution, if it were offered as one, might be defended as equally good with many other definitions or descriptions which are involved in the terms used whenever a constitution is spoken of.

The constitutions which are most frequently mentioned are the English constitution, the constitution of the several states composing the North American Union, the federal constitution, by which these same states are bound together, and various constitutions of the European continent, which have hardly been permanent enough to be submitted to an accurate investigation.

The *vague* notion of a constitution is that of certain fundamental rules or laws by which the general form of administration in a given country is regulated, and in opposition to which no other fundamental rules or laws, or any rules or laws, can or ought to be made.

The *exact* notion of a constitution cannot be obtained without first obtaining a notion of sovereign power. The sovereign power in any state is that power from which all laws properly so called proceed; it is that power which commands and can enforce obedience. Such a power, being sovereign or supreme, is subject to no other power, and cannot therefore be bound by any rules laid down, either by those who have at any previous time enjoyed the sovereign power in the same community, or by any maxims or rules of conduct practised or recommended by its predecessors in power, whether those rules or maxims be merely a matter of long usage or solemnly recorded in any written instrument. The sovereign power for the time is supreme, and can make what laws it pleases without doing any illegal act, and, strictly speaking, also, without doing any unconstitutional act. For this word constitution, taken in its strongest sense, can never mean more than a law made or a usage sanctioned by some one or more possessed of sovereign power, which law or usage has for many generations been observed by all those who have successively held the sovereign power in the same country. To modify or destroy such a rule or law might be unwise, as being an act in opposition to that which many successive generations had found to be a wise and useful law; it might be dangerous as being opposed to that to which the prejudices of many generations had given their sanction; and it might lead to resistance on the part of the governed, if either their own interest or their passions were strong enough to lead them to risk a contest with the sovereign power. If (as would generally be admitted) the assembled parliament of Great Britain and Ireland possess the sovereign power, there is no act which they could do which would be illegal, as every body must admit: and further, there is no possible act which they could do which would be unconstitutional, for such act would be no more than repealing some law or usage having the force of law which the mass of the nation regarded with more than usual veneration, or enacting something at variance with such law or usage. For example, if the next assembled parliament should abolish the trial by jury in all cases, except criminal matters, or where the crown is the prosecutor, such an act might be called by some illegal, unconstitutional, and unwise. But it would not be called illegal by any person who had fully examined into the meaning of the word law; it would not be called unconstitutional by any man who, having called it illegal, wished to be consistent with himself: it could only properly be called wise or unwise by those who had reflected sufficiently on the nature of the institution and its operations to know whether such a modification would do more good or harm.

The words constitutional and unconstitutional appear to be only strictly applicable to such a case as the following: where the sovereign power being invested in one, or two, or five hundred, or all the males of an independent political community who are above a certain age, or in any other number in such a community, lays down certain rules to regulate the conduct of those to whom the sovereign power intrusts the legislative functions. Such are the Constitutions of the several states composing the North American Union, and such is the Constitution of the Federation of these several states. In these several states the people, in the mass, and as a general rule, are the sovereign. The people assembled by their delegates, named for that especial purpose, have framed the existing Constitutions; and they change the Constitutions in the same way whenever the majority of the people, that is, when the sovereign, chooses to make such change.

These Constitutions lay down certain rules, according to which the legislative, executive, and judicial functionaries must be chosen; they fix limits to their several powers, both with respect to one another, and with respect to the individuals who compose the sovereign. They do ordain and declare the future form of government. For example, the Constitution of Virginia of 1776, declares "that all ministers of the Gospel of every denomination shall be incapable of being elected members of either House of Assembly, or of the Privy Council." The same rule, we believe, forms a part of the recently amended Constitution of the same state. If the Virginia legislature were to pass an act to enable clergymen to become members of the House of Assembly or of the Privy Council, such an act would be unconstitutional, and no one would be bound to obey it. The judiciary, if such a matter came before it, would, in the discharge of its duty, declare it unconstitutional, and such co-called law could have no further effect than if any unauthorised body of men had made the rule.

A constitution then is nothing more than an act of the sovereign power, by which it delegates a part of its authority to certain persons, or to a body, to be chosen in a way prescribed by Act of Constitution, which at the same time fixes in a general way the powers of the body to which a part of the sovereign power is thus delegated. And the sovereign power changes this Constitution whenever it pleases, and in doing so acts neither constitutionally nor unconstitutionally, but simply exercises its sovereign power. No body can act unconstitutionally but a body which has received authority from a higher power, and acts contrary to the terms which fix that authority. Wherever then there is a sovereign power, consisting either of one, as the Autocrat of Russia, of three members, king, lords, and commons, as in England (provided these three members do possess the complete sovereign power), or of all the males born of American citizens and of a given age, as in most of the United States of North America—such sovereign power cannot act unconstitutionally. For to act unconstitutionally would be to act against a rule imposed by some superior authority, which would be a contradiction.

A constitutional government may be either purely democratical, as those of the United States of North America, or it may be republican, that is, a government in which the sovereign power is simply defined as not being held by one person. It may be of such a kind that it shall approach very near to a monarchy, if the king or other head of the state is by the constitution invested with very great powers, or such powers as may enable him to overpower, overawe, or render incapable of action, the other limbs of the Constitution. A constitutional government may be of the aristocratical kind, as England, where the power of the crown is now very limited in practice, and is in effect wielded by the small number who for the time obtain the direction of affairs by means of being able to get a majority of the House of Commons; for this body, though elected by the people, cannot yet be considered as a really popular body. The French king, under the Charter, had greater powers than the English monarch has in fact, though in theory it may seem otherwise. The King of the French presided in his own Cabinet; the English Cabinet deliberates without the presence of the sovereign, whose wishes, in opposition to those of the Cabinet, can never be carried into effect. The Cabinet consists of the responsible ministers; they are the king's servants, but so long as they are in office they act as they please. But whatever variety of form there may be in constitutional governments, the essential element to a constitutional government, as here understood, is an assembly of representatives chosen by all the people, or by a considerable proportion of them. This is the body on which a constitutional government depends for its strength, its improvement, and its existence. This is the element out of which ought to come all the ameliorations of the condition of the people which can be effected by legislative measures. The limb or member of a constitutional government, which is composed either of hereditary peers, or of peers named for life by a king, is from its nature an inert body. It may resist unwise and hasty change, but it is not adapted for any active measures.

The policy of having a constitution in a state where the sovereign power is in the hands of all the citizens may be defended on general grounds of convenience. When the community have settled that certain fundamental maxims are right, it is a saving of time and trouble to exclude the discussion of all such matters from the functions of those to whom they have by the constitution intrusted legislative power. Such fundamental rules also present a barrier to any sudden and violent assumption of undue authority either by the legislative or executive, and oblige them, as we see in the actual workings of constitutions, to obtain their object by other means, which, if not less dangerous in the end, are more slow in their operation, and thus can be detected and are exposed to be defeated by similar means put in action by the opposing party. There are disadvantages also in such an arrangement. Constitutional rules when once fixed are not easily changed; and the legislative body when once established, though theoretically, and in fact too, under the sovereign control, often finds means to elude the vigilance and defeat the wishes of the body to which it owes its existence, and from which it derives its power. One of the great means by which these ends are effected is the interpretation of the written instrument or constitution, which is the warrant for their powers. The practice of torturing the words of all written law, till in effect the law or rule is made to express the contrary of what seemed to be at first intended, appears to be deeply implanted in the English race, and in those of their descendants who have established constitutional forms on the other side of the Atlantic. The value of all written instruments, whether called constitutions or not, seems considerably impaired by this peculiar aptitude of men to construe words which once seemed to have one plain meaning only, so that they shall mean anything which the actual circumstances may require, or may seem to require.

It is beside our purpose to discuss the advantage of a Constitution in a community where the sovereign is one. Being supreme, the sovereign may change the Constitution when he pleases. It may be said that if the constitution is good, and has been allowed to stand by several successive possessors of the sovereign power, it obtains an apparent prescriptive authority, which is the more binding on the sovereign, as the mass of the nation habitually regard this same Constitution as something which even the sovereign cannot touch with impunity. It would shock common prejudice if the actual sovereign were to violate that which has been sanctioned by his predecessors, and is recommended by an apparently higher antiquity than the power which, in the actual sovereign's hands, appears to be of more recent birth. The precise meaning of what is called the English Constitution must be got from the various writers who have made its origin and progress their study. In reading them it may not be amiss to bear in mind that the word Constitution, as used by them, has not the exact, but the vague meaning as explained above.

States where there is a king, or other person with corresponding name and power, are now most usually distributed into the two classes of monarchies and constitutional monarchies. The term Monarchy is a proper term to express a form of government in which one man has the sovereign power, as in Russia. The term Constitutional Monarchy is not an appropriate term, because the word monarchy is not capable of a limitation of meaning without the implication of a contradiction in terms. Still the expression is used, and it is understood to express those states in which the kingly power is limited or defined by a written instrument, which also lays down certain general rules affecting the form of government and the condition of the people, which are not to be varied by any legislative act. Such an instrument was the French Charte [Charte], under which France, instead of being a monarchy, as it was once, became a constitutional state, or, as it is called, a constitutional monarchy. This act, which proceeded from the king (Louis XVIII.), could not be revoked by any future king consistently with good faith; and its attempted violation by Charles X. produced a revolution.

When a nation has reached a certain point in its social progress, a participation in the sovereign power becomes a universal desire. It does not follow that a nation will be better administered because the people participate in the sovereign power, but they will not be satisfied till they do participate in it; and that is the important matter for an absolute power to consider. The representatives may often, and will certainly sometimes, enact laws which are mischievous to themselves; but that is an incident to, or an accident in, a constitutional system, not its essential. The essential of a constitutional system is, to call all men into political activity as members of a state, to secure the highest degree of individual freedom that is consistent with the general interest; to establish a real national character, by making each man a potential and living member of the body corporate; and, above all, to keep a tight and steady hand upon the public purse; to see that no more taxes are raised than are necessary for the due support of the administration, and to see that they are raised in such a way as to bring the largest sum into the treasury with the least detriment to the individual. Freedom of publication, or, as it is usually called, the liberty of the press, is in modern times indispensable as a means of maintaining constitutional freedom where it exists, and of attaining it where it does not. In Prussia it is restrained by a censorship; in France it is checked by severe enactments, together with a system of warning, and a power of suspending the publication of newspapers. In England the freedom of the press is amply secured both by law and usage. In the actual state of Germany, in which political life hardly exists, the establishment of a true constitutional government in Prussia would be the commencement of a new era for the Germanic nation. The Russian subjects of the Czar of Muscovy, or of the greater part of his dominions at least, may be at present as contented and as well governed as they would be under a constitution; for a constitution, in order to be beneficial, must be founded upon a representation of a whole nation which has political knowledge, or of a majority so large that the minority shall be insignificant when compared with it.

In the article Charte an account is given of the constitution of France; and of that of the United States of North America, in Geog. Div., under that head; America and England enjoy a higher degree of constitutional freedom than any other states. Since 1848 Sardinia has possessed a representative constitution, and has still more recently acquired a free press. The struggles of Prussia and the results will be found in the Geog. Div., under Prussia. Spain has made extraordinary efforts to obtain the advantages of a constitution. [Cortes.] Some of the smaller states of Germany have constitutions, as Würtemberg, Hanover, Baden, Hesse Darmstadt, Hesse Cassel, Nassau, &c. The European States which have no constitution are Russia, Austria, the Ottoman Empire, Naples and Sicily, the Papal States, Grand Dukedom of Tuscany, Dukedom of Parma, Dukedom of Modena, Dukedom of Lucca, &c. The constitutions of Mexico and of the Republics of South America resemble, in some respects, that of the United States, but have not yet acquired stability. Brazil has a constitution and a representation.

For the nature of a federal government, which necessarily implies the notion of a constitution, see Federation.

CONSTITUTIONS AND CANONS ECCLESIASTICAL. King James I., in the first year of his reign in England, by his writ directed to the Archbishop of Canterbury, summoned and called the "bishops, deans of cathedral churches, archdeacons, chapters and colleges, and the other clergy of every diocese within the province of Canterbury," to meet in the cathedral church of St. Paul in London, to "treat, consent, and conclude upon certain difficult and urgent affairs mentioned in the said writ." The persons so summoned met in convocation, and "agreed upon certain canons, orders, ordinances, and constitutions, to the end and purpose" by the king "limited and prescribed unto them;" to which the king, out of his "princely inclination and royal care for the maintenance of the present estate and government of the Church of England by the laws of this realm now settled and established," gave his royal assent by letters patent, according to the form of the statute of the twenty-fifth year of King Henry VIII. The king, by his prerogative royal and supreme authority in causes ecclesiastical, commanded these said canons, orders, and constitutions to be diligently observed, executed, and kept by his loving subjects of the kingdom, both within the provinces of Canterbury and York, in all points wherein they do or may concern every or any of them; and the king also commanded that every minister, by whatever name or title soever he be called, shall in the parish church or chapel where he hath charge read all the said canons, orders, ordinances, and constitutions once every year, upon some Sundays or holydays, in the afternoon before divine service.

The canons and constitutions may be divided into fourteen heads, which treat as follow: 1. Of the Church of England. 2. Of divine service, and administration of the sacraments. 3. Ministers, their ordination, function, and charge. 4. Schoolmasters. 5. Things appertaining to churches. 6. Churchwardens, or quest-men, and side-men, or assistants. 7. Parish clerks. 8. Ecclesiastical courts belonging to the archbishop's jurisdiction. 9. Ecclesiastical courts belonging to the jurisdiction of bishops and archdeacons, and the proceedings in them. 10. Judges ecclesiastical and their surrogates. 11. Proctors. 12. Registrars. 13. Apparitors. 14. Authority of synods. The number of constitutions is one hundred and forty-one. The authority of these canons is binding on the clergy, but not on the laity, except so far as is stated under the head Canon. The authority of Canon 77 may be doubted; it is this: "No man shall teach, either in public school or private house, but such as shall be allowed by the bishop of the diocese, or ordinary of the place, under his hand and seal; been found meet as well for his learning and dexterity in teaching, as for sober and honest conversation, and also for right understanding of God's true religion; and also except he shall subscribe to the first and third articles afore-mentioned simply, and to the first ten clauses of the second article." The 78th Canon provides that "curates desirous to teach shall be licensed before others:" and the 79th declares "the duty of schoolmasters." The Constitutions and Canons Ecclesiastical were printed by the Society for Promoting Christian Knowledge, London, 1841, together with the Thirty-nine Articles of the Church of England.

CONSTITUTIONS, APOSTOLICAL or CLEMENTINE, are a code of regulations, attributed by some ecclesiastical writers to the Apostles, and said to have been collected by Clemens Romanus. The collection consists of eight books, containing a great many precepts and rules concerning the discipline, doctrine, and ceremonies of the church.

Besides the gospels, epistles, and apocalypse, which now compose the volume of the New Testament, there were, in the earliest ages of Christianity, numerous writings bearing the name of the apostles and apostolical men, of which some are extant at the present time; and it is generally considered that two among the first in order of time are the eight books of Apostolical or Clementine canons, and the Constitutions which are the subject of the present article. That the latter once constituted a part of the New Testament, is evident from the last of the apostolical canons, which states that "The holy and venerable Bible consists of the Old Testament (of which the several constituent books are enumerated) and the New Testament, which consists of the gospels of Matthew, Mark, Luke, and John; 14 epistles of Paul; 2 of Peter; 3 of John; 1 of James; 1 of Jude; 2 of Clement, and the *Constitutions* for you that are bishops, published by me Clement in 8 books, which are not to be divulged to all, because of the mystical things contained in them; and the Acts of the Apostles." (Labbei, 'Collect. Concil.' tom. i.) One of the epistles of Clement, and part of the other which is attributed to him, are included in the Alexandrine MS. Epiphanius (A.D. 400) cites the Constitutions not only as the work of an honest Catholic Christian, but as the divine word and doctrine; yet in his catalogue of canonical books they are not included, and it is contended that the constitutions now extant are not identical with those from which Epiphanius cited.

The authenticity and date of this work have been a subject of much learned contention; and though by far the greater number of critics have pronounced it to be a pseudonymous compilation, made in the third or fourth century, there have been some who support the opinion of its apostolical origin. (See Tillemont, 'Mémoires pour l'Hist. de l'Église,' vol. ii.; Mosheim, cent. i., part ii.; and Neander, 'Genetische Entwickelung,' &c.

CONSTITUTIONS, ROMAN. The word constitutio (from constituere, that is, to set up, to establish) signifies any disposition or appointment; for example, in Dig. iv. 2, l. 9, § 3, an interlocutory decree of the prætor is called constitutio; whilst in D. 45, l. 91, 3 and 4, the expression "quod veteres constituerunt" is used to signify a legal rule or maxim in use among the old Roman lawyers. The decrees and decisions of Roman emperors are also called constitutiones, and, according to Gaius (i. 5), an imperial constitution is what the emperor declares by a decree, or an edict, or a letter. That modern signification of the term, which denotes the fundamental law of a state, was not in use among the Romans; yet Cicero ('De Republica,' i. 45) employs the word to express a similar notion.

During the republic the Roman law was made or developed by decrees of the people in the comitia (leges and plebiscita), by decrees of the senate, and by the edicts of various magistrates, as the prætors and ædiles. [Roman Law.] After the great internal change and revolutions had taken place in the Roman state, and Augustus had united in himself the powers of all the branches of government, with the direction of the senate, and of the assemblies of the people, the imperial authority was firmly established. The emperor not only had the right of issuing edicts, as the magistrates of the republic had done, but he could propose and make entirely new laws. Propositions of laws from the emperor to the senate were called orationes principum. Thus arose the imperial constitutions, with the supremacy of Augustus. But as the arbitrary acts of Sulla, Pompeius, and Julius Cæsar were ratified and confirmed by the people, both in their lifetime, and after their death, this may be considered as the beginning of the system of constitutions. As the institutions of the republic only gradually merged into the imperial autocracy, the voice of the people in the comitia and the decrees of the senate were still respected in form, though not in substance. But after A.D. 24, during the reign of Tiberius, the legislation of the people, and 200 years later the decrees of the senate also, totally ceased. From that era laws were made only by the emperors; and from the time of Constantine the Great, the constitutions were properly called leges novæ, or new laws.

The imperial constitutions occur under different denominations; as edicta (leges edictales), or decrees addressed to and binding on all Roman subjects; decreta or rescripta, which are decisions in particular cases, upon questions proposed to the emperor by public functionaries or private persons; these decisions also were universally binding. We find the terms epistolæ also used, when the decisions were answers to magistrates, and litteræ, when given in reply to private persons. Important single constitutions were often entitled from the emperor who made them, as, for example, "lex Anastasiana."

In course of time the number of these constitutions became so great, that to prevent confusion collections were made, and called codes. The first collections made by private persons were the codices Gregoriani and Hermogeniani, of which we know very little; it being even uncertain if they were two separate codes or only one. Yet it seems that the first collector was Gregorius, and that Hermogenes continued the work. Opinions vary also as to the time when these compilers lived; Blume fixes on the reigns of Diocletian and Maximian, as the period when Gregorius or Gregorianus flourished, resting his hypothesis on a mutilated inscription found in one of the rescripts in his code, in which Blume traces the words "Diocletianus et Maximianus Domini Nostri." (See Irving's 'Introduction to the Civil Law,' p. 28, n. 29.) Hugo thinks it probable that both these lawyers flourished during, or a little after Diocletian's reign ('History of the Roman Law,' book 2, § 379): in a note to that section he mentions as a curious fact that in an old treatise, the 'Consultatio veteris Jurisconsulti,' an extract from the corpus Hermogenianum is ascribed to the reigns of Valentinian and Valens, nearly 100 years later. Their collections, which contained the constitutions from the time of Hadrian to Diocletian, are lost, and we have only some fragments, which were first edited by Jac. Sichardus (Basil, 1528, fol.), together with the Codex Theodosianus. The fragments are in Schulting's 'Jurisprud. Vet. Ante-Just.,' Lugd. Bat. 1712, and in the 'Jus Civile Ante-Just.,' Berol. 1815, purporting to be taken ex Breviario Alariciano; but a more recent and a very valuable edition of these constitutions has been published by Hänel, at Bonn, 1835, entitled 'Codicis Gregoriani et Codicis Hermogeniani Fragmenta.' In connection with the Theodosian code a remarkable document discovered by Clopius deserves mention, the 'Gesta in Senatu Urbis Romæ de recipiendo Theodosiano Codice,' containing the announcement to the senate of Rome by the consul A. A. Glabrio Faustus of the emperor's legislative enterprise, and the other's concurrence, "Quam rem æternus princeps dominus noster Valentinianus, devotione socii affectu filii comprobavi," together with the approbation with which that announcement was received. Nor should the student of this portion of the ante-Justinianean Roman law omit to refer to a work of much research and sound learning for an admirable illustration of the history of the Theodosian era, in Bishop Müller's 'Commentatio historica de Genio Moribus et Luxu Ævi Theodosiani.'

Another and more important collection was made in the reign of Theodosius II., by public authority. The emperor having nominated, in the year 435, a commission of eight persons, including Antiochus, who was their director, for the purpose of collecting the constitutions from the time of Constantine the Great, three years afterwards (A.D. 438) the new code, called Codex Theodosianus, was confirmed by the emperor, and published in the Eastern empire. It contains sixteen books, divided into titles, in which the separate constitutions are arranged, according to their subject-matter, in such a way that many of them are subdivided. Some additions, called novellæ, were afterwards made to the collection of Theodosius. The first five books were lost, but portions of them have been recently discovered at Milan, by Clossius (Clossii 'Theodos. Codic. Genuin. Fragmenta,' Tüb. 1824); and at Turin, by Peyron, ('Codic. Theodos. Fragm. Ined.,' Tur., 1823-4). The best edition of the Theodosian Code is that by Jac. Gothofredus, tom. vi., Lugd., 1665, who also wrote an excellent commentary on it, which was published, together with the text, by Ritter, Leipzig, 1736-54. A copy of this code has appeared in the Berlin edition (1815) of the 'Jus Civile Ante-Justinianeum.'

In the year 506, Alaric II. made an abridgement of the Theodosian Code, adding to it the excerpts from the codices Gregoriani and Hermogeniani, and the works of the Roman lawyers Gaius and Paulus, for the use of the Romans then living in the empire of the Visigoths; the collection is called 'Breviarium Alaricianum,' and is also known by the title 'Aniani Breviarium.'

The last and most important collection of Roman constitutions was made by the order of Justinian. [Justinian's Legislation.]

CONSTRUCTION (Geometry). All formation of lines, figures, &c.,

which is not absolutely implied in the hypothesis of the problem or theorem in question. Thus, in the proof of the theorem, "the square on the hypothenuse of a right-angled triangle is equal to the sum of the squares on the sides," the formation of the right-angled triangle and of the squares is not technically considered as part of the construction, the latter term being only used to imply all the additional formation of figure necessary to the proof.

A question is frequently said to be solved by construction, when it is only meant that a geometrical method of solving it is adopted, as distinguished from an algebraical solution. An equation is also sometimes said to be constructed, in the sense inverse to that in which it is said to be solved; that is, when the roots are given, and the equation is required to be found.

CONSUBSTANTIAL (Consubstantialis) is equivalent in expression to co-essential, and is the translation of the term *ὁμοούσιος*, homoousios, which, in the commencement of the 4th century, was the subject of so much zealous contention among the Trinitarian and Unitarian sects of Christians. The Arians and Eusebians, who asserted the second person of the Trinity, and the adherents of Macedonius, who asserted the third person, to be different and distinct in nature from the first, were strenuously opposed by the Athanasians, who, at the council of Nice (A.D. 325), adopted as the pass-word of their party the term *ὁμοούσιος*, consubstantial, or, as it is Englished in the Nicene creed, "*Of one substance* with the Father." There were three conflicting denominations: those who held the three persons to be of the *same* substance, *ὁμοούσιος*; those who asserted them to be of a *similar* substance, *ὁμοιούσιος*; and those who contended that they were of a *different* substance, *ἀνόμοιος*. Between these parties the dispute was carried on during several years with great violence; and successive councils, composed of hundreds of bishops, continued to meet for the purpose of altering creeds and reciprocating anathemas. In modern times the *ἀνόμοιος* doctrine has been advocated by Dr. Bury in his 'Naked Gospel,' a work which, though condemned and burnt by the University of Oxford, was approved and adopted by Locke, Clarke, and Whiston. The circumstantial particulars of the ancient controversy may be found in the various histories of the councils of that period, and its modern revival in the numerous works on the Unitarian doctrines. See especially the article 'Arianisme,' in Plugnet's 'Dict. des Hérésies.'

CONSUBSTANTIATION, or IMPANATION, is a term adopted by the Lutheran Church to designate its doctrine of the Eucharist, in contradistinction to the transubstantiation of the Church of Rome. Luther, after separating from the Roman Catholic communion, still retained the doctrine of the real presence; but instead of teaching, as the Romanists do, that the priest's pronunciation of the words of consecration at once deprive the bread and wine on the altar of their natural qualities, and transform them into the real body and blood of Christ, he taught that after the consecration of the bread and wine, they are mysteriously *accompanied* with the real body and blood. In short, in *transubstantiation*, the divine body and blood is present *without* the bread and wine; and in *consubstantiation* it is present *with* the bread and wine: the former effects a change of nature, the latter a change of circumstance.

The Lutheran doctrine of consubstantiation was first introduced into the church by John, surnamed Pungens Asinus, a doctor of Paris, at the end of the 13th century. His work on this subject, entitled 'Determinatio F. Joannis Parisiensis de modo existendi Corpus Christi in Sacramento Altaris,' was republished by Allix in 1686.

CONSUL (a word of the same family as *consulere*, to consult), was the title of the highest ordinary magistrate in the Roman republic. King Tarquinius Superbus having been expelled from Rome for his tyrannical conduct, by the joint efforts of the patricians and plebeians, B.C. 409, a republic was established. Instead of kings, two functionaries called consuls (consules, in Greek *ὕπατοι*) were appointed to administer the republic. The first consuls were Lucius Junius Brutus and Lucius Tarquinius Collatinus (or M. Horatius, according to Polybius, iii. 22). The consuls were annually elected in the Comitia Centuriata, and at first were only chosen from the patricians.

As the consulship was established in the place of the kingly office, the consuls also were invested with the same power that the kings had. (Niebuhr's 'History;' Gibbon's 'History,' i. 3; Cicero, 'De Leg.' iii. 3, who ascribes to them "regiam potestatem"). The consulate was, with the exception of the dictatorship, the highest, and, before prætor, ædiles, and censors existed, the only superior administrative office in Rome. The consuls were at the head of the whole republic; the judiciary (jurisdictio), the military (imperium), and the executive powers were all united in them. Accordingly, we find them also called prætores, and judices, and imperatores. They presided in the senate, where they had an elevated seat, and the business in the comitia curiata and centuriata was conducted by them. The consuls created the quæstors of the public treasury, and thus had great influence in the administration of the treasury, the quæstors being dependent on them. They could also conclude peace and make alliances. They were the supreme judges in all suits and criminal trials.

The consuls possessed the same external insignia of honour as the kings, except the golden crown and the trabea (purple cloak), which latter they were only allowed to wear in a triumph. They had a sceptre of ivory, with an eagle at the end. In the assemblies of the people they sat on the sella curulis (an ornamented chair); and like the other senators they wore the toga prætexta. Twelve lictors, with the fasces and axes, as the symbol of the consuls' power over the lives of the citizens, preceded each of them at first; but P. Valerius, called Poplicola, a name which implies his respect, or affected respect, for popular rights, limited the power of the consuls, and curtailed the external symbols of their authority. In the city, the axes were taken from the fasces, and only one of the consuls was preceded by the twelve lictors. From their sentence appeals to the people were allowed. From this time they were deprived of their former power of condemning citizens to death in Rome, and the power of scourging them only remained. But while they were at the head of the army out of Rome, they retained the axes in the fasces and all their former rights. The consul who, according to the settlement of Valerius, was not preceded by the twelve lictors, had a public slave, called accensus, to precede him. The right to the twelve lictors and the supreme authority in matters of administration were enjoyed by the consuls alternately from month to month.

The patricians, after expelling the kings with the help of the plebeians, designed to transfer the royal power to themselves, which they accomplished by securing the election of both consuls out of their own body. The consuls therefore being invested with the supreme power, the struggle of the people with the patricians was at the same time a struggle against the consuls. Their power sustained a great shock by the institution of the tribunes of the plebs. Each of the tribunes, whose number at last amounted to ten, had the right of putting his veto on the measures of the consuls. In order to prevent arbitrary acts of the consuls, the tribune Terrentius, B.C. 461, made a proposition for a code or collection of laws, and in the year B.C. 452 ten men (decemviri) were named for this purpose, who were invested with full powers, and all other functionaries for the time were suspended. The consulate being re-established, the tribunes, B.C. 444, proposed that the people should choose consuls from the plebeians also, a proposal which gave rise to a long and violent contest. The consulship was again suspended, and tribunes of war (tribuni militares) with consular power were appointed, to which office plebeians also were made eligible. At last, B.C. 366, the first plebeian was elected consul. (Liv. vi. 42; vii. 1. 2, 21-6.) Afterwards both consuls were on several occasions plebeians.

In the mean time the extension of the state made it impossible for the consuls to perform the increased duties of their office, and new functionaries were created. In B.C. 442, the censors, and B.C. 365, the prætors, were created, which latter had the judicial functions previously attached to the consulate. In relation to these new magistrates, the consul was called magistratus major, or superior magistrate.

Though the consular power was thus much diminished, it was still very great. All the officers of the state, except the tribunes, were under the consuls; they summoned the meetings of the senate, received all despatches, and gave audiences to foreign ambassadors. In time of war they were commanders-in-chief, and the election of the military officers partly depended on them. In critical times the consular power was made unlimited by the decree of the senate, "videant consules ne quid respublica detrimenti capiat" (they should take care that the republic sustained no harm). Under such circumstances they could require the strictest obedience from all the citizens; and they resumed their right to condemn to death without appeal.

The imperium or military command was granted to the consuls by the lex curiata [COMITIA], whereby a province (*provincia*) was assigned to them. The term *provincia* originally denoted the power given to discharge some public duty out of Rome, particularly the command of the army in conquered countries; and these countries themselves were called provinciæ (provinces). When a consul, after the expiration of his term of office, was appointed to govern a province, he was called pro-consul.

At first no particular age was a necessary qualification for the consulate. But by the lex Annalis, proposed by the tribune L. Villius, in the year B.C. 181, a certain age was required for each magistrate; and the consul must be forty-three years of age. But this law was not always observed; M. Valerius Corvus was elected consul in his twenty-third, and Scipio Africanus in his twenty-eighth year. No one could legally be re-elected till after an interval of ten years; but M. Valerius Corvus was re-elected six times and Marius seven times.

The candidate for the consulate was required to be at Rome when the election took place in the comitia centuriata, a rule which was also sometimes not regarded. The elder of the two consuls first received the fasces, until the Emperor Augustus prescribed, by the law called lex Julia and Papia Poppæa, that he should take them first who had most children. The time of election varied at different periods of the Commonwealth; but they were always chosen some time before they entered on office, and were called designati. The time of entrance on office likewise varied; but about B.C. 154 it was fixed that they should always enter on their office on the 1st of January. The years were named after the consuls, and annual registers were kept for that purpose, which were called Fasti Consulares. When the consuls entered on their office, they went in a solemn procession to the capitol to sacrifice to Jupiter Capitolinus; and after this ceremony the senate held a solemn session. Within the five next days they were to take the oath to administer the republic according to the laws; and at the end of their term of office they took a similar oath. Those who had discharged the office of consul were called consulares, and enjoyed a kind of pre-eminence in rank over the other senators.

M AGRIPPA L F COS III
S C

Consular Medal of M. Agrippa.

British Museum. Actual size. Bronze. Weight, 158 grains.

From the time of Sulla and Cæsar, who were elected perpetual dictators, the consulate gradually lost all its powers, and under the emperors it sunk to a mere shadow and a name. Yet consuls were sitll annually elected by the people, until the time of Tiberius, who ordered that they should be chosen by the senate. The number of the consuls was much augmented by the emperors; and several kinds of consuls were made, as consules ordinarii, after whom the years still were called; consules suffecti, elected by the emperors; and consules honorarii, who had title and rank, but no power. In the reign of Commodus there were as many as twenty-five consuls in one year. Constantine, however, restored the custom of appointing two consuls only in the year, one for Constantinople, and one for Rome, who were alone to act as supreme judges under the emperor. The last consul at Constantinople, after whom the year was denominated, was Basilius, junior, in the year 1294 A.U.C. or 541 A.D., in the reign of the Emperor Justinianus. The last consul at Rome was Theodorus Paulinus, in the year A D. 536.

CONSUL, an officer appointed by a government to reside in some foreign country, in order to give protection to such subjects of the government by whom he is appointed as may have commercial dealings in the country where the consul resides, and also to keep his employers informed concerning any matters relating to trade which may be of interest or advantage for them to know. To these duties are sometimes superadded others having objects more directly political, but into this part of a consul's duty it is not necessary to enter at present, as such functions are assigned to consuls not as such, but in the absence of an ambassador or other political agent. The duties of an English consul, as such, cannot perhaps be better described than by giving the substance of the general instructions with which he is furnished by the government on his appointment.

His first duty is to exhibit his commission, either directly, or through the English ambassador, to the authorities of the country to which he is accredited, and to obtain their sanction to his appointment: the document whereby this sanction is communicated, is called an exequatur; its issue must precede the commencement of his consular duties, and its possession secures to the consul "the enjoyment of such privileges, immunities, and exemptions, as have been enjoyed by his predecessors, and as are usually granted to consuls in the country in which he is to reside." It must be the particular study of the consul "to become conversant with the laws and general principles which relate to the trade of Great Britain with foreign parts: to make himself acquainted with the language and with the municipal laws of the country wherein he resides, and especially with such laws as have any connexion with the trade between the two countries." It is the consul's principal duty "to protect and promote the lawful trade and trading interests of Great Britain by every fair and proper means;" but he is at the same time "to caution all British subjects against carrying on an illicit commerce to the detriment of the revenue and in violation of the laws and regulations of England, or of the country in which he resides;" and he is to give to his own government notice of any attempt at such illicit trading. The consul is "to give his best advice and assistance, whenever called upon, to her Majesty's trading subjects, quieting their differences, promoting peace, harmony, and good-will amongst them, and conciliating as much as possible the subjects of the two countries upon all points of difference which may fall under his cognisance." Should any attempts be made to injure British subjects in person or in property, he is to uphold their rightful interests and the privileges secured to them by treaty. If, in such cases, redress cannot be obtained from the local administration, he must apply to the British minister at the court of the country in which he resides, and place the matter in his hands. The consul must transmit to the Secretary of State for Foreign Affairs, at the end of every year a return of the trade carried on at the different ports within his consulate, according to a form prescribed. He is also required to send quarterly an account of the market prices of agricultural produce in each week of the preceding three months, with the course of exchange, and any other remarks which he may consider necessary for properly explaining the state of the market for corn and grain. It is further his duty to keep his own government informed as to the appearance of any infectious disease at the place of his residence. The consul is required to afford relief to any distressed British seamen, or other British subjects thrown upon the coast, or reaching by chance any place within his district, and he is to endeavour to procure for such persons the means of returning to England. He is to furnish intelligence to the commanders of queen's ships touching upon the coast where he is, and to obtain for them, when required, supplies of water and provisions, and he is to exert himself to recover all wrecks and stores belonging to queen's ships when found at sea, and brought into the port where he resides.

In most cases consuls are subjects of the state by whom they are appointed, but this is by no means an invariable rule, and they are sometimes the subjects of the country in which they reside, or of some other country foreign to both. In some of the less important places, vice-consuls are selected for filling the office from among the mercantile class, and it occasionally happens that they are engaged in commercial pursuits at the port where their official residence is fixed.

Consuls or vice-consuls are appointed by the English government, at all the chief ports with which the nation has commercial relations, but the precise number is always varying. The salaries paid vary not only in the manner above stated, but likewise according to the particular circumstances attending the appointment, a residence in some countries being necessarily more expensive than in others. In addition to their salaries, consuls are in the receipt of fees on signing various documents, but these fees are of small amount.

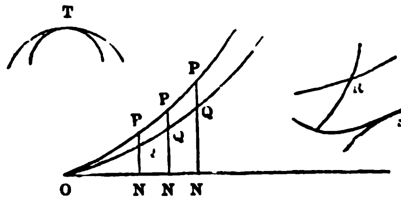
CONSUMPTION, PULMONARY. [Phthisis Pulmonalis.]

CONSUMPTION, MESENTERIC. [Marasmus.]

CONSUMPTION, in political economy, is the end of production; the use, the expenditure, of articles produced. It is unnecessary here to enter upon any examination of the theories of *productive* and *unproductive* consumption, which have so largely occupied the attention of writers upon political economy. We have stated the general principle under the head Capital. The natural relations between production and consumption appear very unlikely to be greatly disturbed in any condition of society in which there is freedom of labour and security of property. The most injudicious and extravagant consumption on the part of the few is, in its degree, a stimulus to a more strenuous production on the part of the many; and under these circumstances there is sure to be that excess of production over consumption which constitutes capital. The creation of capital shows that the production has been greater than the unproductive consumption. A judicious and well-regulated expenditure on the part of the few would doubtless afford a more certain encouragement to the industry of the producers, and the excess of production over consumption would, in the long run, be greater. Whatever injury the improvident consumption of individuals may cause to themselves, it is quite clear that the producing class of society will always repair the waste of the spending class: that in point of fact there will be an excess of production over consumption, wherever the course of industry is not impeded by bad laws, or by a wasteful consumption on the part of a government. Whenever a government engages in the ruinous consumption incidental to war, for example, a very powerful stimulus may indeed be given to particular branches of industry; but other branches of industry that would have been encouraged had their money remained in the pockets of the tax-payers, will proportionately be depressed. The compensating power of production that is called forth in all cases of private consumption must be deranged, or unequally and therefore imperfectly excited, by the consumption of the state.

CONTACT (Geometry). Two lines, one of which at least is curved, are said to be in contact when they have a common point, and recede from that point in such a way that the deflection of the one from the other will, if a sufficiently small departure be taken, become as small a fraction as we please of that departure; that is, if there be no limit to the smallness of the ratio which PQ may be made to bear to ON, as we approach the point O. The subject will be further discussed mathematically in Tangent; Curvature; Curves, Theory of; and we shall at present confine ourselves to pointing out the connection between the preceding definition, which is refined and mathematical, and the obvious ocular phenomenon, by perception of which we immediately admit a marked difference of character between *contact*, as shown at S, and simple *intersection*, as shown at R.

All our perceptions of lines being ocular and physical in the first instance, there is a *minimum visibile*, or least visible distance, at which lines will run into each other. Now if PQ and ON always preserve such a ratio to each other that the *minima visibilia* of these lines arrive nearly together, PQ will not be lost to sight before ON, and the curves will continue distinct up to the very point of meeting. But if PQ diminish so rapidly as compared with ON, as to be lost to sight while



ON is still visible as a length, the two curves will appear to coincide for a visible length, which forms the principal ocular feature of contact. But this *practical* contact is not admitted in geometry, a science of reason, in which no length is considered as invisible; so that contact is only said to exist where the ratio of PQ to ON diminishes—not merely very much—but without limit. Let ON and PQ be the fractions x and v of a linear unit. If then v diminish without limit when compared with x, but always retain a finite ratio to x^2, the contact is said to be *of the first order;* if v also diminish without limit when compared with x^2, but always retain a finite ratio to x^3, the contact is said to be of the second order, and so on. These different orders of contact exhibit nothing to the eye but a closer approach, the higher the order of contact; except in this, that contacts of an even order are always accompanied by the *intersecting* coincidence shown at S, while contacts of an odd order make the curves tangent to each other in the sense in which the word is used by Euclid, as at T.

CONTAGION, THE MATTER OF, a poison which, on entering the blood, produces a definite train of morbid phenomena, and which communicates to the blood the property of generating a similar poison, capable of producing precisely similar morbid phenomena. Considered as a morbific matter *sui generis*, contagion, then, is an agent which produces a disease of a definite nature, one of the distinctive characters of which is that in its progress a peculiar matter is secreted from the blood, which, when introduced into the blood of another individual, produces precisely the same disease. The term contagion is also in common use to denote the actual propagation of diseases of a specific nature from person to person. Such diseases, so propagated, are called contagious; and the matter by which they are propagated is called contagious matter or contagion.

The disease called small-pox exhibits a series of morbid phenomena peculiar to itself. These peculiar phenomena constitute it a distinct or generic disease. The pustules formed in its progress, the formation of which is one of the series of morbid phenomena distinctive of it, contain a peculiar secretion, a specific poison, which, on being introduced into the blood of a person previously in sound health, as by inoculation, produces in that person small-pox. This disease, then, presents all the characters of a contagious disease.

According to the etymological signification of the term, the propagation of disease from person to person by contagion depends on the actual contact of the body which receives with that which communicates the poison. But direct contact is not indispensable to the propagation of a contagious disease. There are contagious diseases which are absolutely incommunicable without direct contact; but there are others which are capable of communication both by contact and without it. A particle of the matter of small-pox, for example, placed in direct contact with the body, will produce small-pox; but the matter of small-pox is likewise capable of being dissolved or suspended in the air; and the air thus loaded with small-pox matter, on coming in contact with the body, is capable of producing small-pox. Hence contagious diseases are divided into two great classes; into those in which the contagious matter acts only by positive contact of person with person, and into those in which it acts both by positive contact and through the medium of the air. Contagion may therefore be said to be immediate or mediate, contactual or remote.

Contagion is carefully to be distinguished from infection. [INFECTION.]

CONTEMPT. A contempt in law is a disobedience of the rules, orders, or process of a court of justice, or a disturbance or interruption of its proceedings. Contempts by a contumacious resistance to the process of a court, such as the refusal of a sheriff to return a writ, are punishable by attachment; but contempts done in the presence of the court, which cause an obstruction to its proceedings in administering the law, may be punished or repressed in a summary manner by the commitment of the offender to prison or by fining him. The power of enforcing their process, and of vindicating their authority against open obstruction or defiance, is incident to all courts; and the means which the law intrusts to them for that purpose are attachment for contempts committed *out of* court, and commitment and fine for contempts done *in facie curiæ*. [ATTACHMENT.]

CONTENT (contentus, contained), the quantity of space contained in any portion of space, measured by the number of times which some arbitrary unit is contained in the space. Thus, linear content is simply LENGTH; superficial content is AREA or surface; solid content (in which sense the word is principally used), also called volume, is the number of solid units contained in a space. These solid units are always cubes, described on the unit of length. Thus, when the inch or foot is employed in measuring lengths, the cubic inch or cubic foot is always employed as the measure of solid content.

The solid content of a rectangular parallelopiped (or figure like a box) is found by multiplying together the units in the lengths of its three dimensions. Thus, 3 feet of length, 2¼ feet of breadth, and 4 feet of height, give 3 × 2¼ × 4, or 30 cubic feet.

The solid content of any cylinder or prism is found by multiplying together the number of square units in the base and the number of linear units in the altitude; and one-third of a similar product is the content of a pyramid or a cone. The content of any irregular solid bounded by planes must be found by dividing it into pyramids.

Weight is thus connected with content accurately enough for common purposes. Multiply the number of cubic *feet* by 1000 times the specific gravity; the result is the number of ounces avoirdupois. Roughly, multiply the number of cubic feet by the specific gravity, and five-ninths of the result is the number of cwts. Thus, the specific gravity of brick being 2, a cube of bricks 20 feet long every way weighs $\frac{5}{9}$ of 20 × 20 × 20 × 2, or 8889 cwt.

To find the solid content of a sphere, take $\frac{377}{90}$ths of the rad. × rad. × rad. Thus, the radius of a sphere being 4 feet, the number of cubic feet contained is 4 × 4 × 4 × 377 ÷ 90, or 268·1.

CONTINGENT REMAINDER. [REMAINDER.]

CONTINUED BASE, in Music, is the figured base of a score used throughout, and so called to distinguish it from the vocal base, as well as from the base staves assigned to particular instruments. The term is only to be found in very old music, and is now become obsolete.

CONTRABAND. [CUSTOMS DUTIES.]

CONTRACT. [AGREEMENT.]

CONTRACTION, in Surgery, an abnormal and permanent alteration in the relative position and forms of parts, arising from various causes. Under the heads ANCHYLOSIS, and DISTORTION, some of the more remarkable results of contractions have been pointed out. In this article we shall describe the nature of club-foot and wry-neck, and point out the recent mode of treating these contractions by surgical operation, which has been remarkably successful.

Club-foot, *Talipes*, is the term which has been applied to all kinds of distortion of the foot. Four species have been described: *talipes varus*, distortion of the foot inwards; *talipes valgus*, eversion of the foot; *talipes equinus*, forced extension; and *talipes calcaneus* or *talus*, extreme flexion of the foot upon the leg. Till within a recent period it was a generally received opinion, that all forms of club-foot consisted in a malformation of the bones of the tarsus, more particularly the astragalus, and this malformation was traced to a diseased condition of the bones. It is a curious fact, however, that Hippocrates attributed club-foot to the unnatural contraction of one set of ligaments and the elongation of another. Whether this be the original cause of the distortion may be doubted, but there can be no doubt as to its being a result, and that the only malformation which exists in the parts is removed by relieving the contraction of the ligaments. It is, however, to Delpech in modern times that we are indebted for a sound view of the nature of club-foot, and more particularly for suggesting, though himself unsuccessful, the modern operation for its relief. Two cases of club-foot, which had been produced after the bones had attained their full development, led him to regard the irregular action of the muscles as the cause. To this conclusion also Stromeyer of Berlin was led, by an inquiry in which he engaged, on the occurrence of paralysis in the muscles of inspiration. The following are the various sources of distortion dependent upon irregular action of the muscles, according to Dr. Stromeyer.

1. Structural changes in the muscles, inflammation and wounds, with loss of substance.

2. Debility and inactivity of antagonists, produced either by wounds of tendons or the bellies of antagonist muscles, or by paralysis of the nerves of antagonist muscles.

3. Diminution of voluntary power in the entire limb through which the flexors or extensors preponderate over the extensors or flexors by the constant organic contraction of the muscles.

4. Painful affections of the part, restraining or prohibiting motion, such as that from inflammation of a joint.

5. Increased energy in the muscle, morbid contraction or motion in the muscular fibres, tonic spasm.

The various modes of treatment of club-foot formerly pursued indicated the want of a definite knowledge of its nature. They were mostly mechanical, and seldom effected the object they had in view. The mode of treatment now more generally pursued is the use of mechanical means after the performance of a surgical operation. The operation consists in dividing the tendons of the contracted muscle, which admits of the restoration of the malformed parts to their normal position, and the space between the divided ends of the tendon is filled up with new matter, and the function of the muscle is normally performed. This operation, simple as it is, was never performed till the year 1784, when Lorenz, a surgeon at Frankfort, divided the tendo-achillis for the cure of a case of club-foot, under the direction of Thilenius. The same operation was afterwards unsuccessfully resorted to by Sartorius and Michaelis. In 1816 Delpech again attempted it, and upon more philosophical principles than his predecessors, but he also failed. This did not prevent Stromeyer from repeating the operation in 1831, which was perfectly successful. In 1833 and 1836 he published two memoirs, containing six successful cases. It was speedily performed again by several surgeons in England and on the Continent, and the value and utility of the operation are now universally admitted. The principal rule to be observed in the operation is not to cut through more parts than is necessary, and to divide the tendon of the contracted muscle. The division of the tendo-achillis is however only calculated to relieve talipes equinus and the slighter cases of varus. But in the severer forms of varus, the tendons of the tibialis posticus, flexor longus pollicis, and sometimes of the tibialis posticus, require division. In valgus the tendons of the peronei as well as the tendo-achillis require division. The principal part of the treatment takes place after the operation, and consists of applying various mechanical means for the restoration of the parts to their normal position. This treatment is generally commenced from two to four days after the operation. A great variety of apparatus have been designed for the purpose, but each case requires a peculiar adaptation of the means for effecting the reduction of the parts.

Club-hand does not occur so frequently as club-foot, but the distortion is of precisely the same nature, and requires for its removal the application of the same measures.

Wry-neck (*Caput obstipum, Torti-collis*) is a disease of the same nature as the preceding, and most frequently arises from the unequal contraction of the muscles of the neck, originating in some one of the causes previously mentioned. The consequence is that the head is permanently inclined towards one of the shoulders. Sometimes this disease arises from disease in the vertebræ or from the contraction of cicatrices after severe wounds and burns of the neck. In the former case the wry-neck can seldom be removed, but in the latter the cicatrix may sometimes be advantageously divided, and the wound allowed to heal again with the head in its natural position. Where it depends on contraction of the muscles, the same operation may be had recourse to as is used for the relief of club-foot and club-hand. It is a curious fact that the operation for dividing the muscles in wry-neck had been recommended and practised long before it was found to be generally applicable to the treatment of contractions. When it is determined to treat wry-neck by mechanical means without operation, the best apparatus is that of Jörg. It consists of a pair of leather stays, and of a band or fillet which goes round the head. To the stays is attached a pulley, over which runs a band to the back of the ear, in the direction of the muscles of the neck, and which can be tightened by means of a screw. It thus acts on the head as the muscles would do if they were in action.

Dr. Little of London has recently published a work on the application of the Stromeyerian operation to contractions depending on what is called partial ankylosis. These ankyloses depend upon some organic or functional lesion of tendon or muscle, arising from one of the following causes: 1. From sloughing or adhesion. 2. From spasmodic contraction. 3. From organic contraction through paralysis of antagonist muscles. 4. From contraction owing to long-continued rest of the limb. When this kind of ankylosis has not existed for a great length of time, or occurs in young persons, a division of the contracted muscle, and a careful extension of the limb afterwards, is very often followed by a complete restoration of the function of the ankylosed joint.

The same causes which produce the above-named diseases give rise to the irregular action of the eye called squinting, and the operation of Stromeyer has been found perfectly successful in this deformity. [SQUINTING.]

(Little, *On Ankylosis*; Little, *On Club-Foot*; Cooper's *Surgical Dictionary*; Cooper, *First Lines of Surgery*; Articles 'Anchylosis' and 'Club-Foot,' *Cyclopædia of Surgery*.)

CONTRALTO; CONTRATENOR. [ALTO.]

CONTRARY and CONTRADICTORY. Two propositions are commonly said by logicians to be contrary when the one denies every possible case of the other; and to be contradictory, when one being universal, the other denies some of the things asserted in the first. Thus, the contrary proposition to "every A is B" is, "no A is B," and its contradictory is, "some As are not Bs."

Contrary propositions may be both false, but cannot be both true; as in "all angles are equal," and "no angles are equal." But of contradictory propositions one must be true and one must be false; either "all angles are equal," or "some angles are not equal." One of the most common fallacies of conversation and debate (and occasionally of written argument) is fixing the assertion of the contrary upon one who simply contradicts. And, on the other hand, nothing is more common than to assume a contrary as proved upon grounds which establish only the contradictory.

The most easy way of establishing general propositions is, in many cases, the refutation of the contradictory; and here is another source of error, since the refutation of the contrary is frequently supposed to have the same effect.

In common language, the two words are used in the same sense; persons are said to maintain *contrary* sides of an argument, when their conclusions are not the technical contraries of the logicians, but only contradictory of each other. The common question, "Have you anything to say to the *contrary*?" always means, "Can you *contradict* this?"

CONVENT, from the Latin *conventus*, an assembly or meeting together. This word is used in a double sense, first, for any corporation or community of religious, whether monks or nuns; and secondly, for the house, abbey, monastery, or nunnery in which such monks or nuns dwell. Shakspere uses it in the first sense, when he says of Wolsey—

> "At last, with easy roads, he came to Leicester,
> Lodged in the abbey; where the reverend abbot
> With all his convent honourably received him."
> Hen. VIII., act iv., sc. 2.

Addison uses it for the building:—"One seldom finds in Italy a spot of ground more agreeable than ordinary that is not covered with a convent."

Furetière, who wrote his dictionary in the time of Louis XIV., says there were no fewer than 14,000 convents formerly in France.

Convent, as related to the foreign military orders, meant the principal seat or head of the order. Furetière says, "La Commanderie de Boisy, près d'Orleans, est le Convent général de l'Ordre de St. Lazare."

The earliest inhabitants of convents were termed Cænobites, from the Greek words *κοινός* and *βίος*, as living in community. They dwelt chiefly in Egypt. Fleury ('Hist. Eccles.,' 4to, tom. v. p. 14, Paris, 1720,) dates their institution as early as the days of the Apostles; others, probably with more correctness, give them a later origin. St. Pachomius, abbot of Tabenna, on the banks of the Nile, who was born at the close of the third century, is believed to have been the first person who drew up a rule for the Cænobites. (Moreri, 'Dict. Histor.,' tom. viii.) [MONASTERY.]

CONVENTION, MILITARY, a treaty made between the commanders of two opposing armies concerning the terms on which a temporary cessation of hostilities shall take place between them. It is usually solicited by that general who has suffered a defeat, when his retreat is not secure and small chance is left of maintaining his position; and it is seldom refused by the victor, since without incurring the unavoidable loss attending an action, his force becomes immediately disposable for other operations.

In 1757 the Duke of Cumberland, when in danger of being surrounded, entered into a convention with the Duke de Richelieu, through the medium of Denmark, by which, on consenting to disband all his auxiliaries, he was allowed to retire with the English troops across the Elbe. And in 1799, when the Anglo-Russian army failed in the attempt to deliver Holland from the French power, the Duke of York made a treaty with General Brune by which the invading force was allowed to re-embark on condition that 8000 French and Dutch prisoners of war in England should be restored.

After the battle of Vimeira in 1808, the Duke of Abrantes, having been defeated, and fearing a general rising in Lisbon against him, sent General Kellerman to the quarters of the British commander-in-chief, to request a cessation of arms, and propose a convention by which the French troops might be allowed to retire from Portugal. This being granted, it was finally arranged in the convention that they should not be considered as prisoners of war; and that, with their property, public and private, their guns and cavalry horses, they should be transported to France: on the other hand, all the fortresses which had not capitulated were to be given up to the British, and a Russian fleet, then in the Tagus, was to be detained in English ports till after the conclusion of a peace. This is the celebrated convention which was made at Lisbon, and is generally but improperly called "of Cintra." It excited much dissatisfaction both in Portugal and England. (Napier, vol. i.) By the appointment of a committee consisting of one individual of each of the three nations, all causes of complaint were, however, finally removed.

CONVENTION PARLIAMENT. Two days after the abdication [ABDICATION] of James II., the Prince of Orange invited the lords spiritual and temporal, to the number of about ninety, who had taken their places in the House of Lords, together with such persons as had sat in Parliament in the reign of Charles II., to the number of about a hundred and fifty, with the aldermen of London, and fifty of the common council, to meet him, and he requested them "to consider the state of the country, and to communicate to him the result of their deliberations." They did so, and the recommendation was that he should summon a convention of the estates of the realm. The prince accordingly despatched circular letters to the several counties, universities, cities, and boroughs, for the election of members. The convention, or parliament, as it was afterwards declared to be, passed the Act of Settlement, which declared the throne vacant, and conferred the crown, with constitutional limitations to its power, on the Prince and Princess of Orange jointly. The Convention Parliament was dissolved 29th January, 1691. (See "Popular History of England," by Charles Knight, vol. iv., p. 448, *et seq.*)

CONVENTION TREATIES. These are treaties entered into between different states, under which they each bind themselves to observe certain stipulations contained in the treaty. In 1843 two acts were passed (6 & 7 Vict. c. 75 and c. 76) for giving effect to conventions between her Majesty and the King of the French and the United States of North America for the apprehension of certain offenders.

The act relating to France (c. 75) legalises the convention entered into with the government of that country for the giving up of offenders who may escape from France into England. On requisition duly made by the French ambassador, a warrant will be issued for the apprehension of fugitives accused of having committed the crimes of murder (as defined by the French code), attempt at murder, forgery, or fraudulent bankruptcy; and any justice before whom they may be brought is authorised to commit them to jail until delivered up pursuant to the ambassador's requisition. Copies of the depositions on which the original warrant was issued, duly certified as true copies, are to be received as evidence. But no justice is to issue a warrant for the apprehension of any French fugitive unless the party applying is the bearer of a warrant or document, issued by a judge or competent authority in France, authenticated in such a manner as would justify the arrest of the supposed offender in France upon the same charge. The secretary of state will order the person committed to be delivered up to the person or persons authorised to receive him. If the prisoner committed shall not be conveyed out of her Majesty's dominions within two months from the time of his committal, any of her Majesty's judges, on application made to them, and after notice of such application has been sent to the secretary of state (or to the acting governor in a colony), may order such person to be discharged, unless good cause shall be shown to the contrary. The act is to extend to all her Majesty's present or future possessions, and to continue in force during the continuance of the convention.

The act relating to America (c. 76) is similar in its nature and purposes to the one relating to France; but the crimes specified include, in addition, piracy, arson, and robbery, and do not include fraudulent bankruptcy. Difficulties, however, have arisen as to the jurisdiction of either country as to crimes committed at sea. A murder may be committed on an English subject on board an American vessel (or vicé versâ), and in whichever country it arrives it is undecided whether either country has jurisdiction over the case.

In 1844 a case occurred of a fraudulent French bankrupt who had escaped to England, and the French government demanded that he should be given up under the Convention Treaty. He was arrested and taken to prison; but before the surrender could take place he applied for writ of habeas corpus, on the ground that fraudulent bankruptcy was an offence unknown to the law of England, and that therefore it was contrary to law to arrest him or keep him in custody on such a charge. The warrant of commitment did not specify that the prisoner should be given up on requisition duly made according to the act, but the words were, "until he shall be delivered by due course of law." In consequence of the defective application of the Convention Treaty in this particular case the prisoner was discharged.

CONVERGENT, CONVERGENCY, DIVERGENT, DIVERGENCY. When a series of numbers proceeding without end, has terms which diminish in such a manner that no number whatsoever of them added together will be as great as a certain given number, the series is called convergent. But when such a number can be added together as will surpass any given number, however great, the series is called divergent. Thus, of the two following series—

$$1+\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+,\ \&c., \text{ and } 1+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\&c.,$$

the first is convergent, for no number of its terms, however great, will amount to 2: the second is divergent, and the sum of its terms may be made to exceed any number. By going a mile, then half a mile, then a quarter of a mile, &c., two miles could never be completed: but by going a mile, then half a mile, then one-third of a mile, &c., a hundred million of miles, or any greater number, could be surpassed.

The subject of the convergency of series is one of fundamental importance in the whole of the mathematics; but it is only recently that it has been treated, in works on algebra, in the manner which its importance requires. Algebraical writers once imagined that a series, however obtained, is safe and fit for use, whether convergent or divergent. This opens a question which has caused much discussion, and on which we cannot here enter. We shall state the results of investigation on the subject, together with the references to sources of information.

1. Series of increasing terms are certainly divergent.

2. Series of decreasing positive terms are divergent, unless the terms diminish without limit.

3. Of series of positive terms which diminish without limit, a test of convergency or divergency may frequently be given as follows. Let a, b, c, d, e, &c., be the terms of the series: form the new series

$$\frac{b}{a},\ \frac{c}{b},\ \frac{d}{c},\ \frac{e}{d},\ \frac{f}{e},\ \&c.\ \ \ldots\ldots\ (\text{A});$$

then, if there ever arrive a term of the series (A), from and after which all the terms are not only less than unity, but tend towards a limit which is less than unity, the series is certainly convergent: but if the terms aforesaid become greater than unity, and continue so from and after a given term, the series is certainly divergent: and if the limit in the first case be not less than unity, but unity itself, the series may be either convergent or divergent, and each particular case must be examined by itself. Instances of both sorts can be given.

4. Series of the form $a+bx+cx^2+dx^3+ex^4+\&c.$, can always be made convergent by giving a sufficiently small value to x, except only in the case where the terms in the series (A) increase without limit from and after any term. If they do not increase without limit, let L be the limit; then the preceding series is convergent whenever Lx is less than unity, is referable to the preceding case when Lx is equal to unity, and divergent when Lx is greater than unity. But if $\mathrm{L}=0$, the preceding is always convergent.

5. Series whose terms are alternately positive and negative, are always convergent when the terms diminish without limit, and the error committed by taking any number of terms to stand for the whole value, is never so great as the first term thus rejected. For instance, if the answer to a question be $1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\&c.$, then 1 is not wrong by $\frac{1}{2}$, $1-\frac{1}{2}$ is not wrong by $\frac{1}{3}$, $1-\frac{1}{2}+\frac{1}{3}$ is not wrong by $\frac{1}{4}$, and so on. The results are alternately too great and too small.

6. When such a series as the last has its terms not diminishing without limit, but towards a finite limit, the sum of any number of terms, increased by half the limit, is never wrong by so much as the first-rejected term differs from the limit.

7. When series produced by algebraical development have their terms alternately positive and negative, the error committed by stopping at any term is never, *in any case which the student will meet with*, so great as the first rejected term, even though the series become afterwards one of continually increasing terms. If, then, such a series have the first few terms rapidly diminishing, a close approximation may be made by means of them to the real value of the expanded function. For instance, in the series $1-2x+2.3x^2-2.3.4x^3+\ldots.$ (in which an attempt to calculate from the whole series would be utterly futile, since, however small x may be, there must be terms of every degree of magnitude) when x is small, an approximation may be made to its value from the terms which decrease. Thus if $x=\cdot 1$, in which case the series is

$$1-\cdot 2+\cdot 06-\cdot 024+\cdot 0120-\cdot 00720+\&c.,$$

(and the first term which surpasses that preceding, is $2.3.\ \ldots.\ 11\,x^{10}$): the aggregate of the terms up to $2.3\ \ldots.\ 9x^8$ inclusive, will not differ from the true value of the expression by so much as $2.3\ \ldots.\ 10x^9$, or ·0036288. The proof of this curious proposition, in the vast number of cases in which it is true, may be deduced from Lagrange's Theorem on the Limits of Taylor's Series. ('Lib. Useful Knowledge,'—Differential Calculus, p. 78.)

Series which are functions of x may be divided into—1. Those which are sometimes convergent, and sometimes divergent, such as the development of $(1+x)^n$. 2. Those which are always convergent at last, but in which the appearance of divergency (increasing terms) may be continued as long as we please, such as the development of ϵ^x. 3. Series which are always divergent, but to which a similar appearance of convergency can be given, such as $1+2x+2.3x^2+\ldots.$, and the like. 4. Series which are always convergent or always divergent, and never can be made to exhibit any symptom of approach to the other state, such as

$$x+\frac{1}{x}+\left(x^2+\frac{1}{x^2}\right)+\ldots \text{ and } \frac{x}{1+x^2}+\frac{x^2}{1+x^4}+\ldots$$

The series which are always convergent, both in reality and appearance, and upon which, therefore, an arithmetical algebraist would reckon with most security, do, in fact, offer difficulties of a very peculiar character. They are the only ones in which the usual algebraical generalisations would lead to absolute error (so far as has yet appeared).

On this subject generally, see Peacock's 'Algebra,' and 'Report on Analysis' ('Rep. Brit. Assoc.,' vol. ii.); Cauchy, 'Cours d'Analyse;' Grunert, 'Supplemente zu Klugel's Wörterbuche der Reinen Mathematik,' in the article 'Convergenz der Reinen;' 'Encyc. Metrop.,' article 'Calculus of Functions.' See also SERIES.

CONVERSE. We here state the ordinary theory of the logical converse. Converse, in logic, means a proposition which is formed from another by interchanging the subject and predicate, thus: the converse of "Every A is B" is "Every B is A." But care must be taken to put the proposition in its usual logical form before conversion. Thus the converse of "Every A has a B" is not "Every B has an A." For the proposition first stated is

$$\text{Every}\ \begin{bmatrix}\text{A}\\ \textit{subject}\end{bmatrix}\ \begin{bmatrix}\text{is}\\ \textit{copula}\end{bmatrix}\ \begin{bmatrix}\text{a thing which has a B}\\ \textit{predicate.}\end{bmatrix}$$

and the converse is "Every thing which has a B is an A."

Of the four forms to which all assertions can be reduced, namely (A) "Every A is B"; (E) "no A is B"; (I) "some As are Bs"; (O) "some As are not Bs", the logical converses (so called) are those in which the new subject appears with the same degree of generality of assertion as the old one. Thus the converse of "Every A is B", is "*Every* B is A.' Consequently in the first and fourth forms, or the general affirmative and the particular negative, the logical converse is not necessarily true. Thus "Every A is B,' does not give "Every B is A" *necessarily*, but only "some Bs are As'. The latter is called by writers on logic conversion *per accidens*, a term which, as Dr. Wallis has declined to explain it, we shall leave as we find it, adopting the phrase diminished or limited conversion, and calling the first kind simple conversion. The only other method of conversion which has a definite name is that in which the subject and predicate are made contradictory to the former ones, as when we convert the proposition, "All equilateral triangles are equiangular triangles," into "All triangles not equiangular are triangles not equilateral." This is called conversion by contra-position. Restricting ourselves to converses which are necessarily as true as the direct propositions, we have the following rules with respect to A, E, I, and O above.

E and I are simply convertible.

E and A are convertible by diminution.

A and O are convertible by contra-position.

Nothing is more apt to make a beginner believe that "Every A is B" yields "Every B is A," than the study of geometry without close attention to the meaning of terms and the force of the parts of an assertion. For as a majority of the earlier propositions have their simple converses true, the student does not sufficiently reflect upon this being contingent and not necessary.

In mathematical propositions there is a species of conversion which has no name, consisting in the interchange of the predicate with a part only of the subject. Thus if P, Q, R, and S be four circumstances, of which the existence of any three makes the fourth also exist, we may observe this species of conversion in passing from the first to the second of the following propositions:—

Every (thing which gives P, Q, and R) is (a thing which gives S).

Every (thing which gives P, Q, and S) is (a thing which gives R).

Thus of the following set of circumstances: 1. That two figures be parallelograms; 2. That they be equiangular; 3. That the sides about equal angles be reciprocally proportional; 4. That the areas be equal: exhibit the possibility of this conversion. For (1) (2) and (3) give (4); (1) (2) and (4) give (3); (1) (3) and (4) give (2).

The subject of converse is discussed by Aristotle, 'Analytic. Prior.,' i. cap. 2, &c. See the editions of the 'Organon,' by Pacius, 1597, &c.

CONVERSION. [TROVER.]

CONVEX. [CONCAVE.]

CONVEYANCE (in Law) is a deed or instrument in writing which passes real or personal property. The only conveyances used in the earlier periods of English history seem to have been feoffments and grants, though leases were soon used to pass a limited interest. The possession of land, as well as property of a moveable nature, passed by tradition or actual transfer. The possession of land was given symbolically, by the delivery of a twig, a turf, &c., the charter of feoffment being the evidence merely of the transaction, and not essential to its validity. Hence, in the charter of feoffment, the operative words, or those which expressed the gift or transfer of the property, were used in the past tense, *hath given*, &c.: these terms are still used by some practitioners, although the reason for them has long since passed away.

A grant was applied to the conveyance of incorporeal hereditaments which did not admit of actual delivery into possession. From this difference in their application, a diversity was supposed to exist in the innate qualities of the two modes of conveyance, the feoffment being used to convey the actual possession of land, and operating upon the possession without any regard to the estate or interest of the feoffor; the grant to transfer the right of the grantor to the grantee: the former was formerly defined as a tortious, the latter a rightful conveyance. This definition however was not always recognised by the courts (see Goodright *v.* Forrester, 1 Taunt, 613). The stat. 8 & 9 Vict. c. 106, formally abolished a distinction which often led to inconvenient consequences, and now no feoffment can have a tortious operation.

Sir William Blackstone distinguishes conveyances as original or primary, which are those by means of which the benefit or estate is created, or first arises; and derivative or secondary, whereby the benefit or estate originally created is enlarged, restrained, transferred, or extinguished. This division however is of little practical importance. Conveyances operate either according to the rules of the common law, or under the statute of uses. Conveyances may be further divided into those made by matter of record and by deed. As examples of those by matter of record, we may mention private acts of parliament, and the queen's grant; and, until those modes were abolished by the statute 3 & 4 Will. IV., c. 74, fine and recovery. Those by deed are by feoffment, grant, bargain and sale, covenant to stand seised, lease, release or confirmation, exchange, surrender. Conveyances simply transferring personal property are called assignments.

By the statute 13 Eliz., c. 5, voluntary or fraudulent conveyances of real property are rendered void, as against the creditors of the party making the transfer: and the 27th Eliz., c. 4, extends similar, and in some instances more extensive, relief to subsequent purchasers of the same property, although they may have had notice of the prior conveyance. The bankrupt and insolvent laws also provide for the relief of creditors against certain conveyances of real and personal property in derogation of their claims, or made within a specified time previous to the bankruptcy or insolvency.

The old system of conveying by lease and release has been effectually uprooted by the simple enactment of the statute 8 & 9 Vict, c. 106, to the effect that "all corporeal tenements and hereditaments shall, as regards the immediate freehold thereof, be deemed to lie in grant as well as in livery."

In many of the states of North America a simple bargain and sale is the usual mode of conveying real property. In New York it is called a grant; and the conveyance by feoffment and livery of seisin, and also the statute of uses, are expressly abolished by the legislature.

Conveyances in Scotland are made according to the strict principles of the feudal law there established, which imparts to them the appearance of far greater speciality and quaintness than those used in modern English practice.

(Bl. *Comm.*; Butl. *Co. Litt.*; Kent's *Comm.*)

CONVEYANCING is the business of preparing conveyances of real or personal property, of investigating the title of the vendors and purchasers of property, and of framing those multifarious deeds and contracts which govern and define the rights and liabilities of families and individuals. It is carried on by barristers, or by members of the Inns of Court, who having kept twelve terms, obtain a certificate according to the provisions of the 9 Geo. IV., c. 49, and are called certificated conveyancers. [BARRISTER; INNS OF COURT.] The increased number of transactions in this branch of the law has rendered a division of labour and a special course of study necessary.

There are two opposite systems, by which the transfers and transactions of the owners of real property are capable of being carried on; and between the extreme points of which, in some portion or other of the intermediate ground, all existing systems must arrange themselves. In one of these systems, as in the present sytem of England, every transaction is accomplished and evidenced by means of instruments in writing, varying infinitely, and governed by a scientific and ascertained mode of construction. In the other, the effect is accomplished somewhat like the transfer of stock, by a comparatively mechanical operation, a process of book-keeping, of which the evidence is to be kept, not in private muniments, but in the ledger-books or registers of the State.

The respective objects of these systems are, in the one, to protect the rightful owner; in the other, the innocent purchaser. In the latter the State takes upon itself the duty of seeing to the title of the owner whom it admits to registration, and consequently takes upon itself the risk of being deceived; in the former, it leaves the parties to concert titles and transfers in secret and in silence, leaves them unrestrained and unchecked to transact with one another, but compensates this want of interference by the alternative of following the right, by its judicial machinery, against all parties, however ignorant, however innocent, who may have had the misfortune, at any time subsequent to a defective transaction, or wrongful succession, to become the owners or purchasers of the property; limiting that restoration or succession only by reference to certain durations of adverse possession. (Parke's 'Lect.')

In the time of the feudal law, and the period immediately succeeding, restraint was placed on every species of alienation; landed property was rarely the subject of barter. Every transfer of land took place in open court, that is, on the land itself *coram paribus* (before the pares or peers), who were the other tenants of the feudal lord, and who subscribed the instrument of investiture as witnesses (Sulliv. 'Lect.,' p. 58); so that, in the words of Lord Mansfield, it was as notorious who was feudal tenant *de facto*, as who is now *de facto* incumbent of a living, or mayor of a corporation. Land was "of a stubborn nature," money portions were unknown, and personal property did not exist in sufficient quantities to be made the subject of settlement, and consequently conveyancing transactions were few and simple. But the devices of the ecclesiastics to evade the statutes of mortmain, the invention of uses and trusts, and subsequently the passing of the statutes of uses and wills, which enabled the possessor of land to provide for the contingencies which might occur in his family, and to mould his estate according to his whim or fancy, controlled only by the laws from time to time established to guard against the abuse of the privilege, the power of devising real estate, and the multifarious wants of a large and wealthy population, laid the foundation of the system of modern conveyancing. "By means of this system," says a late eminent professor, "there is no device, arrangement, settlement, or disposition which imagination can conceive, or ingenuity construct, which the machinery of the law of England cannot carry into effect with certainty. There is no conceivable purpose to which property may not be applied or rendered instrumental; no event, or combination of events, which can possibly happen in a family, of whatever rank or number, which may not be provided for and met, by a family settlement framed by a master of his art."

Modern conveyancing is conducted on principles which in general are well defined and accurately settled. Of this a remarkable proof was afforded by a statement in Mr. Parke's 'Contre-Projet to the Humphreysian Code,' p. 199, upon the authority of Mr. Preston, that of the cases which came before him (averaging thirty a week), three per cent. only went on to judicial litigation.

The great endeavour, from the earliest times, on the part of the owners of property, has been to be enabled to effect sales and dispositions with secrecy and dispatch, without incurring that publicity which it was the policy of the common law to enforce. Whether it be desirable, for the sake of mercantile credit, to favour secrecy, or promote publicity, in the sale and disposition of property, has been lately much discussed; a general registry has been proposed, and bills for establishing it have been from time to time introduced and thrown out of the House of Commons. [REGISTRATION.]

CONVICT. [PENAL SERVITUDE; TRANSPORTATION.]

CONVICTION. [JUSTICE OF THE PEACE.]

CONVOCATION. The assembling of the clergy of the Established Church, in obedience to a writ from the crown, which issues on the meeting of every *new* parliament. In former times, the archbishops, bishops, and the most considerable abbots, were an integral part of the great council of the nation, and as such took their seats with the barons, with whom they were classed. The bishops who now sit in the House of Lords do so by the same prescription. When the burgesses were summoned to assemble by Edward I., to aid in providing supplies for the public service, the inferior clergy were also called upon to do the same, but they objected to do so under the writ of the king, lest they should acknowledge thereby the authority of the temporal power of the sovereign. The expedient was therefore devised of directing the writ to the two archbishops, so that they might compel the clergy to obey their spiritual head. To this the clergy did not object, and thus at this day the two convocations in the provinces of Canterbury and York are wholly distinct and independent of each other; each summoned and controlled by its own metropolitan, to whom alone the suffragan bishops and clergy of each province owe canonical obedience. Thus before, and for some time after the Conquest, matters of Church and commonwealth were often determined in the same meeting, as well by clergy as laity: that is, the chiefs of either being present. But after the course adopted in the reign of Edward I., upon the summoning of the burgesses as a distinct class, and thereby creating the type of our parliament, the archbishops of York and Canterbury, as to them seemed fit, upon cases of emergency summoned their clergy to assemble in convocation of their own mere motion and authority, and such canons or constitutions as were therein determined on were held binding without ratification from the Sovereign on all subject to ecclesiastical jurisdiction, and such custom continued until the statute of Hen. VII. c. 25, s. 19 (commonly called the statute of præmunire) was enacted. On the meeting of every new parliament the archbishops of Canterbury and York, in obedience to the writ from the crown, convoke the bishops of their respective provinces, and the bishops the clergy of their respective dioceses. They meet and proceed, with those who choose to attend (those who do not attend are pronounced contumacious, but the notification of their contumacy is deferred *sine die*), in the province of Canterbury to St. Paul's cathedral, in York to the minster. Prayers are read, and a sermon delivered, both in Latin; the convocation is then, after a few formal matters, adjourned to a future day and to another place; it then meets for the ostensible despatch of business. In the meantime, the inferior clergy proceed to elect proctors to represent them in their own future assembly; they also select prolocutors to communicate with the upper house as occasion may require. In conformity with the two divisions of the legislature, convocation has its upper and lower house; the former composed of the archbishop and bishops of each province, the latter consisting of representatives termed proctors, who are elected from the incumbent clergy. The mode of election varies; in the diocese of London each archdeaconry selects two proctors, and from the collective number so chosen the bishop names two to attend the convocation; in that of Salisbury the archdeacons, three in number, choose six proctors, and those six select two of themselves to represent them: such also is the custom in the diocese of Lichfield and Coventy. In the diocese of Bath and Wells all the incumbents, that is, rectors, vicars, and perpetual curates, have a conjoint voice in the selection. In the diocese of Lincoln, the six archdeacons, through the agency of commissioners, name two persons as proctors. In the diocese of Norwich, the two archdeaconries of Norwich and Norfolk name one proctor, and those of Suffolk and Sudbury the other. The same (*mutatis mutandis*) is the course adopted in the diocese of Chichester. In the province of Canterbury proper, as distinguished from the dioceses comprising the province *in extenso*, the archdeacons represent the clergy. In the province of York, two proctors are returned by each archdeaconry.* Although convocation meets with all the solemnities due to an important body, its functions are practically of little effect; it assembles, it is true, in obedience to the sovereign command, but it is also within the power of the sovereign to command it to discontinue its sitting. In these days, an effort has been made by some of its members to continue its sittings from day to day without prospect of adjournment; but both in Canterbury and York, and more especially in the latter, the archbishops have resolutely defeated the object of those who have been anxious for a continuous session. The act of parliament (25 Hen. VIII. c. 19) subjects to the penalties of a præmunire (that is, *quasi* high treason) any archbishop who summons a convocation without the sovereign's command, or continues to hold it after notice of the crown to cease to do so. Consequently it is generally prorogued from time to time, with little opportunity even for discussion; and, moreover, the convocation itself is so completely under the control of the crown that it cannot pass any canon (that is, any rule or law affecting the clergy, or matters relating to the Church) without a royal licence. Attempts have recently been made to rescue convocation from its present lifeless state, but hitherto without effect; and the assembly of the clerical parliament, for practical purposes, still remains little more than an empty form.

CONVOLVULIC ACID, *Rhodeoretic Acid, Hydrorhodeoretin* ($C_{62}H_{52}O_{36}$?). A white uncrystallisable acid, produced by the metamorphosis of convolvulin under the influence of alkalies.

CONVOLVULIN, *Jalapin, Rhodeoretin* ($C_{62}H_{50}O_{32}$?). A white gum-like substance, obtained from jalap root. Convolvulin is very slightly soluble in water, insoluble in ether, but soluble in alcohol. Although its alcoholic solution slightly browns turmeric paper, yet it has no basic qualities. It may be detected by its reaction with concentrated sulphuric acid, in which it dissolves with a beautiful amaranth-red colour which disappears after the lapse of some time. Convolvulin is the active principle of jalap, and is highly purgative even in very small doses.

CONVOLVULINOLIC ACID, *Rhodeoretinolic Acid, Rhodeoretinol* ($C_{26}H_{25}O_7$?). A colourless crystalline acid, obtained by the action of dilute acids or of emulsion upon convolvulic acid.

CONVOY, in the military service, is a detachment of troops appointed to guard supplies of money, ammunition, provisions, &c., while being conveyed to a distant town, or to an army in the field, through a country in which there is danger that such supplies may be carried off by the peasantry or by parties of the enemy.

In the navy, the name is applied to one or more ships of war which are ordered to protect a fleet of merchant-vessels on their voyage.

CONVULSIONS, irregular (abnormal) and violent contractions of muscular fibres with alternate relaxations. The muscles of the body are divided into two great classes—those which produce the motions necessary for the due exercise of the organic functions, and those which produce the motions necessary for the performance of one of the animal functions, namely, locomotion. The first division comprehends the class of the involuntary, and the second that of the voluntary muscles. Contractility, the property of shortening itself on the application of a stimulus, is the proper function of the muscular fibre; and by this property all vital motion of every kind which takes place in the living system is performed. [MUSCLE, NAT. HIST. DIV.]

The property of contractility is inherent in the muscle; but the manifestation of this property is wholly dependent on the nervous influence; for if the nervous influence be abstracted from a muscle, its fibres are incapable of contracting, whatever degree of stimulus be applied to them. When the muscular fibre is in a sound state, and is supplied with the nervous influence in proper quantity and of proper quality, the fibre contracts with a given degree of force on the application of a certain amount of stimulus. This degree of contraction constitutes its regular or normal action. Contraction, after it has continued a certain time, is succeeded by relaxation; relaxation, in its turn, yields after a given time to another contraction; this contraction to relaxation, and so on successively according to the order proper to muscular action when natural and sound.

But when, on the application of a given stimulus, the muscular contraction is either more violent or more rapid, or longer continued than natural, that is when it does not yield in proper time to the alternate state of relaxation, the muscular action is said to be convulsive, and the disease termed convulsion is induced. The state of convulsion is also produced when the muscular fibre is excited to inordinate action on the application of a stimulus not natural to it. The function ultimately deranged in convulsion is the muscular contractility; but the function proximately deranged is the nervous influence; the manifestation of disease is in the muscular, but its true and proper seat is in the nervous system.

Both divisions of the muscular system, the voluntary and the involuntary, are subject to this irregular and violent action. When the muscles of animal life, or those of voluntary motion, are thus affected, it constitutes the disease called *convulsion* in its true and proper sense; when the muscles of organic life, or those of involuntary motion, are thus affected, the disease is usually termed *spasm*. This distinction is not indeed invariably and universally observed by medical writers; but it would be very convenient if it were so. When the muscle is rigid and tense, and its contraction is persistent, not quickly alternating with relaxation, the contraction or spasm is called tonic; when the contractions rapidly alternate with relaxations, the convulsion or spasm is called clonic. When the convulsive or spasmodic action is of the clonic kind, but instead of being violent is slight, and when very slight contractions rapidly alternate with relaxations, it constitutes what is called *tremor*.

Convulsions differ, first, in kind, as dependent on an excess or a deficiency of vital energy; secondly, in degree; varying from the most powerful, violent, and persistent contractions, without perceptible relaxations, or with relaxations of very short duration, down to the feeblest contractions, with the most rapid alternate relaxations of the slightest tremor; thirdly, in their seat, affecting either the voluntary or the involuntary muscles, or both simultaneously or in succession; fourthly, in their cause, arising from a primary affection of the nervous system, or from irritation propagated to the nervous system from some other part (primary or secondary); fifthly, in their extent, affecting one part separately, or nearly the whole frame simultaneously (local or general); and sixthly, in their character (simple or specific): simple, when unattended with phenomena which give them a determinate type, that is, when the phenomena consist merely of convulsive or spasmodic action; specific, when the convulsive actions pursue a regular and determinate course, and when, moreover, some particular phenomenon is superadded to the series constituting a distinct form or type of disease. In this latter case the disease receives a generic name. The term epilepsy, for example, is given to the disease when the convulsions come on in a peculiar mode, and pursue a determinate course, and when there is present the superadded phenomenon of insensibility or sopor. On the other hand, in the affection called hysteria, the convulsions come on in a different mode, pursue a different course, and are attended with a different but still a determinate train of morbid phenomena. [EPILEPSY; HYSTERIA.]

Voluntary muscles are far more frequently the seat of convulsions, properly so called, than the involuntary muscles. The diaphragm, indeed, an involuntary muscle, next in importance to the heart, is often affected with a proper convulsive action, constituting the disease called *singultus* or *hiccup*; and the heart itself appears to be occasionally affected with a proper convulsive action, in some of the forms of palpitation, for example; but in general, when the organs of the organic life, as the bronchi, the stomach, the intestines, the urinary bladder, the uterus, &c., are attacked with an affection of this kind, it is much more closely allied, as has been stated, to the nature of spasm than of convulsion.

---

* This summary is taken from Mr. Marsden's recently published volumes.

Of the voluntary muscles, whether those appropriated to locomotion, or those destined to act on foreign bodies under the command of the will, and also of certain muscles which, though not under the direct command of the will, still belong to the animal life, having a close relation either to sensation or motion, there is not one which may not be the seat of convulsion, singly, or conjointly with many others.

The muscles of the eyelids, the muscles that move the ball of the eye, the muscular fibres of the iris, the muscles of the face, and more especially of the lips, the muscles of the tongue, the muscles of the pharynx, the muscles of the jaws, and particularly of the lower jaw, the muscles of the neck, the muscles of the chest, back, and abdomen, and the muscles of the upper and lower extremities, may be severally attacked singly or in combination, simultaneously or in succession, with every degree of convulsion, from the most violent tonic contractions to the slightest clonic tremor or twitching. The particular muscles affected, the particular combinations of the muscles affected, the particular order in which the muscular affections succeed each other, may be indicative of specific diseases of the nervous system or of diseases seated in particular parts of the nervous system. The study of these convulsive affections is therefore most important in a practical point of view, as indicating, at one time, the near approach or the actual existence of highly dangerous diseases, having their primary seat in the brain or in the spinal cord; and at another time pointing to no less formidable diseases of the brain and spinal cord excited by diseases of some distant organ. At the same time it should always be remembered that these affections may be purely functional, and not dependent on organic disease at all.

When convulsions attack a single muscle, or a particular set of muscles, the convulsions are called partial or local; when they attack a great number of muscles simultaneously or in rapid succession, they are called general.

The accession of an attack of general convulsion, whether local or general, is commonly, though not invariably, preceded by premonitory signs, which should be carefully looked for, that measures appropriate to the particular nature of the case may be promptly taken to prevent an occurrence of the attack.

In the actual paroxysm, the features of the face are sometimes hideously distorted; the eyeballs are prominent, staring, vacant, wild, and are rolled in every direction; the teeth gnash; the mouth foams; the tongue protrudes; and the action of inspiration from the passage of the air through the clenched teeth, is attended with a hissing sound. So violent are the contractions, that occasionally the teeth, and sometimes even the bones of the extremities are broken by the force. When the muscles of inspiration are involved, and the respiratory function is much obstructed, the face becomes tumid, bloated, and of a dusky or purple colour; and sometimes even the entire surface of the body assumes a leaden hue, from the obstructed circulation through the lungs and the imperfect aëration of the blood. Such is the obstacle to the progress of the blood, that the blood-vessels sometimes give way, and the blood bursts from the nose, or is effused extensively beneath the skin, the effusion probably preventing irreparable mischief to the brain. At other times the face, instead of being red, is pallid and sunk, and then the pulse is feeble, small, and contracted; as in the former case it is full and strong, and attended with a violent beating of the carotids. The violent contractions of the muscles act upon the bladder and rectum, and expel the contents involuntarily and with force. In all the cases in which the current of the blood is much obstructed, the functions of the brain are proportionally impaired, the general sensibility is diminished, and there is sopor, or even coma; at other times consciousness is but little affected, and the violence of the contractions produces severe pain.

The duration of the paroxysm varies from a few minutes to as many hours. The moment the convulsions subside, the patient commonly falls into a long and profound sleep, from which he awakes suddenly, altogether unconscious of what has happened. The attack is generally succeeded by languor, lassitude, sickness, and a disordered state of the stomach.

The paroxysm commonly returns at uncertain intervals, preceded by the premonitory symptoms just enumerated. But sometimes it proves fatal at the very first attack, by producing apoplexy or asphyxia; and not unfrequently it leaves behind it either paralysis or some definite and permanent form of convulsive disease, as epilepsy, chorea, and so on. The frequent recurrence of the fits invariably impairs, and sometimes wholly destroys, the mental faculties.

In some peculiarly nervous and irritable temperaments, instead of the languor and lassitude which ordinarily follow a severe convulsive paroxysm, the exhaustion is so extreme that the patient falls into a state of profound syncope or fainting, which continues for so long a period as justly to excite alarm; and sometimes the patient actually dies in this fainting fit, the brain never recovering its functions. At other times, the animal life is completely suspended, and the action of the organic life appears to have ceased, but the latter is not wholly extinguished, though its functions are performed so feebly as to afford no indication of their existence; consequently, to all outward appearance the patient is dead; yet he may be only in a state of lethargy or torpor, and may ultimately revive.

The preceding account of a paroxysm of convulsion, is the description of it only as it exists in its severest form. In general even the tonic seizure is a much more mild attack; the convulsions being not violent; affecting only a few muscles at a time, and rather passing in succession from one set of muscles to another, than attacking a great number simultaneously. In general too the convulsions are unattended with the obstruction of respiration; are without the abolition of sensation; in short, are without the permanent and dangerous interruption of any function, organic or animal. And more especially when the paroxysm is of a clonic character, the muscles are not rigid, the contractions are not vehement and long-continued, the face is not swollen and livid, but rather pale and sunk, the features are little distorted, the pulse is feeble and rapid, and the extremities are cold.

Convulsions are frequently excited in the progress of other diseases, towards the termination of continued fevers, for example, in which they are almost always of bad, and sometimes of fatal omen; at the commencement of eruptive fevers, as small-pox, measles, scarlet fever, &c., when, though generally indicative of a severe form of disease, they are not so alarming as at the close of continued fever; in inflammatory affections of the brain; in hooping-cough; in cramp; in disordered states of the reproductive organs, and more especially of the uterus, and in long-continued suppression or imperfect performance of the catamenial function.

The causes of convulsions are exceedingly numerous and varied. There is, without doubt, a constitutional predisposition to such affections. They occur far more frequently in the nervous temperament than in any other. The distinctive character of the nervous temperament is muscular mobility combined with nervous irritability. The muscular fibre is relaxed, delicate, and weak; the nervous fibre is peculiarly sensitive, while it is proportionally without energy. Other powerful causes are, peculiar conformation of the body, namely, a feeble frame, with a largely developed head: a relaxed and delicate fibre; a full and plethoric habit; a constitution often manifestly propagated from parent to child; all circumstances capable of producing over-excitement, or in any other mode of inducing debility, physical or mental; an idle and luxurious mode of life; too much indulgence in sleep; neglect of regular and active exercise, and, as would appear, certain electrical conditions of the air, by which the nervous system is rendered more susceptible of impressions, and its vital energy is more rapidly exhausted.

The exciting causes are those which act either upon the animal or upon the organic portion of the nervous system. It has been stated that contractility, though a property inherent in the muscular fibre, can be excited only through the agency of a stimulus derived from the nervous system. All the muscles which are under the control of the will, or which depend on an act of volition for the exercise of their function, derive their nervous stimulus from a particular portion of the nervous system, namely, the spinal cord. Modern physiology has demonstrated that the nervous fibres which supply the stimulus necessary to voluntary muscular motion are different from the nervous fibres which communicate sensation. The first, the motive nerves, communicate with a particular portion of the spinal cord; the second, the sentient nerves, communicate with another portion of the spinal cord. Now, it is found that whatever disturbing influences act immediately upon the motive nerves, or upon that portion of the spinal cord with which the motive nerves are in direct communication, constitute most powerful exciting causes of convulsions. But there is so close a sympathy between the sentient and the motive portion of the spinal cord, and between the spinal cord and the brain, that any disturbing influence which acts powerfully on the one is rapidly communicated to the other. It is indeed seldom that it is possible to trace the seat of the irritating cause either to the motive or to the sensitive portion of the nervous system exclusively; that would imply an accuracy and completeness of knowledge which pathologists are at present far from possessing. All that the present state of knowledge almost ever admits of is to trace the seat of the irritating cause to some portion of the spinal cord or brain; and this, which is nearly all that can be done in any other case, is sufficient to connect the morbid condition of the organ with its disordered function. There are then morbid conditions of the spinal cord and brain which are clearly ascertained to be immediately connected with that disorder of their functions of which convulsions are the result.

Such are, 1. A disordered state of the circulation of the blood through these organs. One of the conditions, the most essential to the due performance of the functions of the nervous system is, that the spinal cord and brain receive a certain supply of arterial blood. If the quantity of blood which flows to these organs be deficient, syncope will be induced, with a diminution or loss of muscular power: of this state convulsions, always of a clonic character, are a constant result. If the blood transmitted to the spinal cord and brain do not circulate through the blood-vessels with a certain impetus and velocity, but be retained either in the capillary arteries or veins, or in both, the state termed congestion [CONGESTION] will be induced, of which convulsions, also in general of a clonic character, are a constant result. If the blood sent to the spinal cord and brain be in preternatural quantity, and if it circulate with preternatural energy, the state of inflammation will be induced, of which convulsions, always of a tonic character, are a constant result. Whether, then, the balance of the circulation be disturbed by deficiency or excess in the quantity of the circulating blood, or deficiency or excess in the motion of it, it will prove alike an exciting cause of convulsions. 2. Precisely the same results are produced if there circulate through the blood-vessels blood vitiated in quality, blood too much venalised, or too much arterialised, or impregnated with poison. The character of the convulsions induced by exciting causes of this class vary essentially according to the nature and extent of the vitiation of the blood and the kind of poison with which it may be imbued. 3. Extravasation of blood upon the surface or into the substance of the spinal cord and brain, by the rupture of the blood-vessels; or the effusion of the serous portion of the blood, occasioning direct pressure on the nervous matter. 4. Organic changes in the constitution of the nervous substance, as a preternatural softening or a preternatural hardening of it. 5. Morbid growths within the nervous substance, forming tumours of various natures and sizes. 6. Mechanical injury of the nervous substance, from the irritation occasioned by the deposition of bony matter on the investing membranes of the nervous substance, or from spiculæ of bone growing out from the inner table of the osseous cases that inclose it. 7. Mechanical violence directly applied to the nervous substance, as from a blow or fall, by which a shock, exhaustive of its vitality, may be communicated to it, or its substance injured, or its circulation disturbed. Such are the more powerful exciting causes which act directly on the animal portion of the nervous system.

But convulsions may be equally induced by the action of an irritating cause on the organic portion of the nervous system. The irritation excited in the organic nerves is transmitted to the communicating branches of the spinal and cerebral nerves, and is by these communicating branches conveyed to the spinal cord or brain. It is in this manner that irritating substances in the stomach or in the intestines induce convulsions, as indigestible or acrid substances taken as food, or acrid matters generated or evolved during the digestive process, or retained by long-continued constipation [CONSTIPATION] in some part of the alimentary canal; or the accumulation of acid, or the presence of worms, &c. Many other noxious agents which act upon one or other of these nervous circles, or upon both conjointly, might be enumerated as the exciting causes of convulsions; but those which have been stated may suffice to indicate the kind of noxious agents which induce this affection, by disturbing the functions of the nervous system.

The treatment in every case of convulsion must be directed to the subduing of the paroxysm and to the prevention of its return. There are certain things proper to be done the instant a person is seized with a fit of convulsions, with a knowledge of which it is desirable that every one should be familiar. The patient should be immediately surrounded as completely as possible with fresh cool air. If he be seized in a small heated and crowded room, circumstances of themselves sufficient to produce a paroxysm in a person strongly predisposed to it, he should be removed into a spacious apartment, the windows of which should be thrown open, and every one whose assistance is not absolutely required should be excluded from the room. In the male, the neckcloth should be immediately untied, and the face, neck, and bosom freely exposed to the air; in the female, the stays should be unlaced, and every thing tight about the body should be removed. If the skin be cool, and the face pallid and sunk, the patient should be placed in the horizontal posture; if the skin be hot and the face flushed, he should be sustained in the sitting or the erect posture, in order, in the former case, to favour the flow of blood to the spinal cord and brain; and in the latter to retard it.

The remedies employed to put an end to the fit must of course depend on the nature of the exciting cause, and on the pathological condition of the nervous system.

COOKING APPARATUS. If cookery be raised to the dignity of a chemical art (and there is no good reason why it should not), we ought to regard cooking vessels as chemical apparatus. It is, however, chiefly in the mode of applying and economising heat, that such apparatus calls forth the exercise of ingenuity.

Of the ordinary cooking vessels we need say nothing; their simplicity has rendered them familiar to all; but of the modern cooking stoves and apparatus, many examples evince skilful arrangement.

In the so-called "bachelor's kettles," of which Spiller's is one specimen, the problem seems to be to determine in how short a space of time, and with how little trouble, can a frugal meal for one person be prepared. Spiller's apparatus consists of a kind of saucepan, with a small opening on one side to admit air, and a flue fixed in the opposite side to let off smoke. A very shallow tea-kettle forms the cover to this saucepan. In the middle of the saucepan is a small iron grating, and on this grating is placed one of those small net-work arrangements of sticks which constitute "patent firewood," and which are now sold so cheaply at one farthing each. This wood being kindled, and the kettle placed over it, the heat is so confined as to make the water in the kettle boil by the time the wood is consumed. With some of these contrivances a kind of small frying-pan is sold; and by using a larger piece of patent firewood, time is allowed for a small dish of savoury cookery after the water has boiled: the kettle being quickly replaced by the pan. There is a certain amount of usefulness in the contrivance which makes it available for others besides the "bachelors" whom the patentee seems to have had in his thoughts.

Many varieties of gas cooking-stoves have been introduced, in which gas jets are made to yield heat sufficient for the processes of boiling, stewing, roasting, baking, frying, &c. Among others is Defries' "Economic Gas Cooking-stove," which is made to suit either large or small culinary wants. Mr. Boggett's gas stoves, for which a patent was taken out in 1850, comprise many varieties, differing from each other chiefly in the mode of making the heat practically available. There is one form called the Liverpool gas-stove, in which separate departments are provided for roasting, baking, broiling, frying, boiling, stewing, and steaming. For many of these purposes the gas is supplied in a ring of jets. On a festive occasion at Exeter, the late M. Soyer cooked a monster joint of meat by means of this apparatus; the meat weighed 565 lbs., and was cooked in a gas oven in five hours, with an expenditure of about five shillings' worth of gas.

The kitchen ranges and other stoves and grates in which coal or coke is burned, are for the most part contrived both for warming apartments and for cooking; but some are designed especially for cooking. The "cottager's stove," manufactured by Messrs. Bailey, of Holborn, consists of a square iron case supported on four legs. Inside this case, and near one end, is a fire-pot, the top of which opens into a flue to carry off the smoke; the rest of the vacant space constitutes an oven; while the top, being flat, is available for many cooking processes. In some of these stoves a boiler is attached to that end which is nearest to the fire. It has been shown that, in one of these stoves, 100 lbs. of meat and 115 lbs. of vegetables, can be cooked with an expenditure of 20 lbs. of coal.

The cooking apparatus of Messrs. Burbidge and Healy is founded on the plans of heating developed by Mr. Sylvester. There are, as in many other similar kinds of apparatus, a large range, an oven, a boiler, a hot-plate, and various subsidiary parts; but its chief features consist in the economising of fuel, and in lessening the amount of radiation sent into the middle of the room. This radiation is an annoyance to the persons present, and involves a loss of some of the heat produced; and it is unquestionably an improvement, other things being equal, if nearly the whole of the heat produced can be applied to the purposes for which it is primarily intended.

Among the many forms of cooking apparatus, that of Mr. Brown is distinguished by having the whole kitchen range, with its oven, boiler, hot-plate, &c., set in a framework which may be placed in any sized fire-place, however large, without setting. The throat, or opening to the flue, is formed in the iron-work of the range itself, so as to be at once determinate in shape and size. With this range is used an automaton roasting jack, arranged in a singular way. In front of the range is placed a sort of semi cylindrical oven, with the usual hooks and dripping-pans for roasting. A hollow tube projects from the lower part of the oven; and when the oven and range are arranged for cooking, this tube is thrust into an opening beneath the fire-place of the range. While the contents of the oven are exposed to the action of the fire, a current of air is continually drawn through the tube into the oven; and this current sets in rotation a vane-wheel to which the suspended hooks are attached.

Remington's roasting apparatus is, as the name imports, adapted to roasting only. The meat is suspended from or below a jack. There are concave reflectors above and below, which reflect the heat so as to act on the upper and lower surfaces of the meat. The centre of both reflectors is hollowed; the fat which drips from the meat passes through the hollow in the lower reflector into a sort of cup beneath, and is from time to time poured into another vessel, which is perforated and placed over the hole in the upper reflector. The inventor hence calls his apparatus not only a roaster, but a "self-acting baster."

M. Soyer devised a pretty and scientific cooking stove, in which spirit of wine is the fuel used. A lamp is so placed as, by its heat, to boil spirit placed in a vessel above; the steam or vapour of this boiling spirit has no outlet, except through a tube which gradually becomes so narrow as to resemble a blow-pipe; this blow-pipe is placed opposite to a second spirit-flame, and the blowpipe wafts such a constant stream of spirit-vapour into this flame as to heat it greatly, and to make it act rapidly on small cooking vessels placed above it. There is a good deal of chemical ingenuity shown in thus feeding one spirit-flame by vapour derived from another; but the apparatus is somewhat costly.

Mr. Norman has devised a mode of using steam as well as interior radiated heat, in a cooking apparatus. There are two vessels, one within the other, having a space of about three-quarters of an inch between them at top and bottom: this space is partly filled with water. There is a tray for meat, and another tray, perforated, for vegetables, &c. When the vessel is heated, the steam from the water is received by two small pipes, and projected upon the contents of the lower tray; after which, the steam ascends through the perforations to the upper tray.

A lecture delivered at the Royal Institution in 1857, by Captain Grant, of the Royal Artillery, gave much useful information on the important subject of cooking in the British army—a subject to which that officer has devoted considerable attention. Captain Grant draws attention to the much neglected fact, that all stoves or grates imbedded in a mass of brick- or stone-work, occasion great waste of fuel by absorbing some of the heat unprofitably, and by sending a further portion unused up the chimney. The polished steel fittings of modern fireplaces reflect much heat into a room which would otherwise be lost; but unfortunately these costly articles are unattainable by the poor, who are most interested in economy. Hence the detached stoves, whether called Dutch, Brussels, or any other name, render more service than fixed grates, although they may not to an equal degree present the cheerful aspect of an open fire. For cooking, the masonry setting is still more improvident of heat; and it is mainly on this ground that so many portable stoves, gas stoves, steam kitchens, &c., have been introduced.

At the North-West Reformatory in the Euston Road, some of the persons benefitted were employed to construct a cooking-stove for their kitchen. It was a detached portable cooking apparatus, in which fuel was used so economically that in 1857 it was found that cooking could be effected for eighty-two persons at a cost of sixpence per day.

The great sufferings of the troops outside Sebastopol, in the winter of 1854-5, from cold, privation, and fatigue, were aggravated by the imperfect arrangements for military cookery. Since that time many improvements have been introduced. On the suggestion of Captain Grant, when Aldershott Camp was first formed, a new kind of cooking apparatus was adopted, primitive in character, but suited to teach soldiers how to cook for themselves more effectively than they have hitherto done. A trench was cut in the ground, and over it was placed a covering of thin iron plates, having a central hole in each large enough to receive an ordinary camp-kettle. A chimney was formed at one end of the trench of sods piled up to the height of three feet; and at the other end of the trench was the fire-place. By this very simple apparatus several regiments cooked their provisions during many months. The next improvement related to battalion cooking-kitchens, when the camp at Aldershott assumed a more complete form. The same principle of the trench was adopted, with modifications; and for two years many of the regiments had their cooking effected in this way. The consumption of fuel requisite for this system is about half a pound of coal per man per day; and the cost is a halfpenny per man per week for three daily meals.

It is a subject for much regret, that English soldiers have never been accustomed to meat cooked otherwise than by boiling. Medical men well know, and on all fitting occasions urge, that this is not the best mode of developing the nourishing qualities of the food. Roasting, baking, frying, and broiling, are processes not adopted in military kitchens in connection with our armies; whereas French soldiers manage to prepare many savoury rations by such means. If soldiers in our barracks wish for a change from the never-varying boiled meat, they club together a few pence, and send their meat to a public bake-house. Captain Grant, like many other intelligent officers, believed that this defect might be overcome by the exercise of a little ingenuity. He has contrived an oven to be introduced in the chimney of his trench-kitchen; and as he makes one chimney serve for two trenches, the oven becomes surrounded by the heated air of two flues. He thus economises heat, and prepares a baked dinner for his men. Without the addition of a single pound of fuel, he found that he could bake 250 lb. at once in a large chimney. So effective is this said to be, that a battalion of a thousand men may be cooked for by two small fires 18 inches square and 6 inches deep.

Captain Grant has still more recently planned a further extension of his simple apparatus, in such form as to enable troops to bake, stew, and steam their food *while actually in the field*. In June, 1859, he made experiments on this subject at Woolwich, in presence of Colonel Tulloh and other officers. The apparatus is fixed to an ordinary four-wheeled advance-waggon, to be drawn by two or more horses, as circumstances might render expedient. The operation of cooking goes on while the vehicle is in transit. A furnace at one end of the apparatus heats the water of a boiler, the steam from which is the chief cooking agent. Steam-pipes communicate from the boiler to a perforated steamer, oven, stew-pan, &c. Each apparatus is calculated to cook food for about 200 men, by means of a very small amount of fuel. The boiler being filled with 120 gallons of water, can have its steam raised in ten minutes, and the cooking can then be conducted while the vehicle is actually in motion. Another apparatus, similar in principle but different in details, has been planned by Captain Grant for making soup instead of cooking joints of meat. It will be an immense boon to the British soldier if these excellent inventions should prove to be as effective in practice as they have been in preliminary trials.

COOLER, COOLING. Various contrivances have been adopted by brewers and distillers for cooling their worts. This has been done by exposing the hot liquor in shallow wooden vessels to the air, and by the use of stirrers or fans to keep the liquor in motion, and thus expose fresh surfaces to the air. The plan has also been adopted of passing spring-water, which in deep wells is usually about 52° even in summer time, through metal pipes placed in the liquor to be cooled.

Wine-coolers are made of porous earthenware, which being soaked in and saturated with water, by its gradual and copious evaporation occasions cold; and in Spain, water-coolers, called *alcarrazas*, are made on the same principle. Coolers of this kind, made of porous clay, lightly baked, and rather thin, are also common in Egypt, where they are often represented on the ancient monuments in a form very much resembling both those now used in Egypt and such as we see in use at Cadiz and other places in the south of Spain. On the monuments of Egypt we sometimes observe a man fanning these earthen vessels with a palm-leaf, in order to promote the evaporation. The Arabs of Egypt are well acquainted with the practice of fanning their earthen vessels to quicken the evaporation. M. Costaz, when in Egypt, made the following experiment on the refrigerating power of these earthen vessels. The thermometer in the shade, but exposed to the air, marked 110°·75 Fahr. during the greater part of the day. At sunset the Nile water was 82°·6; an earthen vessel filled with this water was placed on the deck of the boat in which M. Costaz passed the night on the Nile. At day-break the temperature of the river was the same, but that of the water in the jars was only 61°·25, and more than half of the water was evaporated.

A remarkable mode of cooling liquids was introduced in 1848 by Mr. Lillie of Manchester. It depends on centrifugal force. The liquid is placed in a bowl or colander, either pierced with minute holes all round the sides, or having sides made of wire gauze. Through the intervention of a vertical shaft, this bowl is made to rotate rapidly. The water first rises all round the sides, and then rushes out through the perforations or meshes in a multitude of small streams; these streams, coming in contact either with the ordinary atmosphere in an outer vessel, or still more effectively with artificial currents of air, become rapidly cooled.

Professor Smyth, of Edinburgh University, has suggested a method of cooling the air of rooms in sultry weather. It depends on the principle that air, when compressed, shows a higher temperature than it had before, but resumes its initial temperature on the pressure being removed. The Professor conceived the idea of compressing air, and cooling it while under pressure, in order that, on regaining its original bulk, the temperature should be lower than that of the external air.

COOPERAGE, COOPERING, or the making of casks, barrels, butts, puncheons, hogsheads, tubs, &c., is among the very old mechanical arts. It is supposed that the wine-growers of ancient Italy invented the mode of building up from small pieces of wood vessels which would contain liquids. The coopers of London were incorporated many centuries ago. There is extant a record, under date 1396, in which the Mystery of Coopers applied to the lord mayor for an ordinance, restraining those of the mystery from making vessels for beer or other liquors out of oil- or soap-tuns, whereby the flavour of such beer or other liquors might be injured. This was accordingly ordained. There was another ordinance in 1407, relating to the proper material and workmanship of casks, and to a record of the trade-marks of all the master coopers in London, forty-six in number. By an Act of 1532, brewers were forbidden to make their own casks; and as there is an entry in the books of the Coopers' Company, of a payment of "three pounds, six shillings, and eightpence, for a pipe of Gascony wine that the speaker of parliament had," it has been conjectured whether that curious gift had anything to do with the passing of a statute which threw the whole cask-making trade into the hands of the master coopers of that day.

The trade of cooperage is divided into several distinct branches,—dry coopers, wet coopers, white coopers, general coopers, and back-makers. Dry coopers make the casks for containing sugar, currants, flour, and other dry goods; the work is of a common kind, and is paid for at a low price. Wet coopers make the chief varieties of casks for liquids; the vessels are classed into "large work" and "small work," done by different bodies of workmen. White coopers make tubs, pails, churns, &c., the cleanest and lightest kind of work. General coopers practise all the branches of the trade, without acquiring a high degree of skill in any one. Back-makers, who fabricate the enormous vessels used in breweries, scarcely rank among coopers; they build up pieces of wood in a manner not recognised by regular coopers.

A short description will suffice of each of the above kinds of cooperage.

Small dry work.—Small casks for dry goods are usually made of Quebec oak and of old ship timber. The wood is sawn into lengths, and these into narrower pieces called *codlings*. The codlings are *listed* or chopped with an axe, to make them narrower at the ends than in the middle; and then *cleft* into stave-pieces by a cleaving-knife and a maul. The staves are next *shaved* or *dressed*, a cutting instrument being employed to make them convex on one side and concave on the other. They are then *jointed;* that is, every piece is so shaped on all sides, and from end to end, that all the staves together may make a symmetrical whole, with water-tight joints; in this, the workman relies almost wholly on his accuracy of hand and eye,—an accuracy which nothing but long practice will produce. The cask-heads are usually made of one or two pieces each, properly shaped, and then glued together. By means of temporary circles called *truss-hoops*, the several staves for making one keg are brought together in their proper places, all touching edge to edge at the bulge or widest part, but not yet closed in at the ends. The staves are heated, to enable them to bend without cracking, and the hoops by which they are to be held together are driven on. A groove is cut round the inside of the two ends of the keg, to receive the head and the bottom. The *truss-hoops* at first used are made of iron, and are merely intended to hold the keg together until the head and bottom are put in; they are afterwards removed, and wooden hoops used, made of hazel, birch, willow, ash, or other tough wood. These hoops are bent, notched, and fitted by workmen who carry on this operation alone.

Small wet work.—The smaller casks or kegs for containing liquids differ from those just described chiefly in the greater care necessary; every part is more accurately adjusted, and iron hoops are frequently used instead of wood.

Large dry work.—Large casks for dry goods are made of beech, ash, or oak. The staves are sawn to the proper length; listed or chopped narrow at the ends; slightly dressed or shaved on the side which is to be outwards; jointed or bevelled so as to fit accurately side by side; and thus prepared for building up or putting together. The large casks are more difficult to put together than those of smaller size; but it is done nearly in the same way, by the aid of temporary hoops, within which the staves are adjusted side by side. One man can make a small cask; but it requires two or three to hoop together the staves which are to make a large one. The *chime*, or smooth curved surface of the cask, is produced by a dexterous use of the adze. The permanent hoops, which are to supersede the temporary truss-hoops, are made of birch, hazel, or ash, and are partially prepared before they reach the cooper's hands. The hoops are secured partly by notches and partly by nails.

Large wet work.—Wet work and tight work mean the same thing in the cooper's vocabulary; they refer to the making of casks with the joints so close as to be fitted for the retention of liquids. Rum-puncheons and other kinds of large wet work are made of oak—Quebec, Virginia, Dantzig, Hamburg, or English; the first two are found to be the best for spirit-casks, and the last three for beer-casks. Quebec is the closest-grained, toughest, and most pliable; English is the hardest, most durable, and most expensive to work. The oak is too tough to be split into stave-pieces; it is cut by the saw; and according to the mode in which this sawing is effected, the pieces are called slabbed staves, tongued staves, straight-cut staves, or doublet staves. The successive processes by which a cask is made—the listing, jointing, backing, shaving, head-making, dowelling, firing, trussing, grooving, heading, hooping, &c.—are analogous in general character to those for large dry work, but more precise at every stage, and requiring more skill in the workman. The making of the sides or edges of the staves requires peculiar care. Let it be supposed that a beer-barrel is to be made. Not only must the joints be made so smoothly and accurately that when the staves are brought together they must be perfectly water-tight, but as the cask must hold precisely 36 gallons, and as the staves may vary in thickness, the cooper must so manage his exterior curve as to preserve symmetry, and yet retain a uniform internal capacity. The oval casks, which occasionally adorn the bar of a modern gin-palace, are the most difficult part of a cooper's work; two circular casks of different sizes are partially made and taken asunder, and the staves of the larger are so adjusted as to produce the broad sides of the oval, the ends being formed from the staves of the smaller.

White work.—White cooperage comprises open vessels, such as tubs and pails, generally larger at the top than the bottom; and, unlike casks, such vessels are smoothed on the inside as well as the out. The timber mostly employed is either oak or ash. Almost the whole of the cutting is effected by the instrument called a shave, something like the wheelwright's spoke-shave in its mode of action, but used by the cooper in a great variety of different forms. The building up of the vessel requires great neatness of handling; but not so much practised skill is needed as in large wet work, owing chiefly to the circumstance that such accuracy of dimensions is not needed.

Back-making.—The large brewing vessels called backs are thus made: The bottom is usually set up first. The staves are fitted in and pegged to each other, without reference to any particular proportion between them, some being wide at the top and narrow at the bottom, or *vice versâ*. The workman can bring all into symmetry by adjusting the size and form of the pieces last put in. His work is, in fact, carpentry rather than cooperage.

Dock-work.—In addition to the above, there is a kind of cooper's work done at the Docks, to filled rather than to empty casks. Sugar comes over in hogsheads, containing from 1000 to 1500 pounds each. These are thin and slightly made; they are subjected to rough treatment when the sugar is packed into them, and to rougher on shipboard. As a consequence, the hogsheads are distorted in every imaginable way, when landed at the docks in London, Bristol, Liverpool, or elsewhere. It is a custom, perhaps a necessity, that these hogsheads should be brought into something of a symmetrical shape before the sugar is sold to the dealers. This is difficult work to accomplish with the sugar remaining in the hogsheads, for it frequently happens that several of the staves and some of the hoops have been so shattered as to require removal and replacement by new pieces. Casks containing wines and spirits are always examined at the docks, to test their soundness; and any defective places are repaired by piecing. When such casks are landed in such a damaged state as to be unsafe, the wine or spirit is racked into other vessels, and the damaged cask is remade out of the old materials; this is done, not simply to save the expense of new wood, but because the old and well-seasoned wood is less likely than new to impart a bad flavour to the liquor. It is generally rum-puncheons, made by negroes in the West Indies, which require this process of remaking.

When we consider how mathematically exact all the angles and curves must be, cask-making would seem to be a branch of manufacture peculiarly fitted for the application of machinery. Accordingly, we find that patents are frequently taken out for cask-making machinery. Some of these we shall describe.

One patent, by Mr. Brown, obtained thirty years ago, relates to a system of machinery, of which one part cuts the edges of the staves; another part cuts the groove or chime for receiving the head; a third part cuts the head into a circular shape; a fourth bevels the edge of the head; and a fifth gives a smooth circular surface to the exterior of the cask.

Davison and Symington's patent respecting casks, taken out in 1844, relates to the value of a rapid current of heated air, not only in drying wood, but in removing fungous impurities which often accompany damp wood. They recommend that, in making a cask, instead of drying the wood in the ordinary way before using, by which it is difficult to bend without blistering, it should be cut up quite green, and shaped into staves and heads, due allowance being made for shrinkage. The pieces are easily bent in this state, and being temporarily fastened together, they are exposed to a rapid current of heated air, which carries off all the moisture, and shrinks the pieces to the proper size.

The same patentees also use hot air to cleanse casks after using: a method which they consider to be more effectual and cheaper than the use of steam, which is ordinarily employed in the great breweries. In order to remove from the interior of the cask any fungus or impurity which cannot be removed by the heated air, the patentees use a peculiar kind of chain, which enters at the bung-hole, and is worked about by means of machinery.

Mr. Robertson, a cooper of Liverpool, took out a patent in 1849 for a series of machines of rather complicated character, for making casks and similar vessels. One piece of apparatus is intended to plane, at one time, both sides of the staves which are to form the curved part of the cask; giving a convexity to one surface and a concavity to the other surface of each piece of wood. A second piece of apparatus planes the edges of the staves, giving to each edge the particular slope necessary for the staves to assume a circular arrangement when placed edge to edge. A third machine compresses all the staves together in a circular form, and forces the ends within the hoops which are to bind them together. Another machine presses together the pieces of wood which are to form the head of the cask, cuts them into a circular form, and bevels the edges. A fifth piece of apparatus cuts the groove in which the head is fitted to the cask; and another punches the holes in the iron hoops. Thus, according to the patentee's plans, every part of a cask is made by machinery.

Mr. Samuel Brown patented in 1840 a mode of making metallic casks. The cask is formed of a parallelogram of sheet iron or other metal, turned up into a cylindrical form, with an ordinary lap joint. The head of the cask is formed of a circular piece of metal, cut out and turned up all round the edge; this being forcibly driven into the cylindrical barrel, has rivets placed at intervals of four or five inches all round, which are rivetted through the barrel and through the turned-up edge of the head. The other end of the cask, called the moveable head, is made like the first, but attached in a different manner; in this case, projecting ears of metal are rivetted at proper intervals around the cylinder; and the heads of these rivets being within the cylinder, serve as stops to prevent the head of the cask from being driven in too far. This second head being forced into its place, the ears are bent down upon the edge of the cylinder, and over the raised edge of the head, thereby retaining it firmly in its place. The joints are to be made fluid-tight with any of the ordinary paints or cements.

In 1852, Messrs. Fox and Henderson devised a mode of making iron casks, for the palm-oil trade; they produced casks 43 inches in length by 38 in bulge, containing 214 gallons each.

In the same year, Messrs. Duncan and Hutton took out a patent for machinery for giving form to the jointing-edges of wood-planks for the staves of casks; producing edges to the pieces for forming the cask-heads; drilling the holes for the dowels used in putting together the heads; giving form to the outer edge or circumference of wood-planks for heads; hollowing and bevelling the ends of the staves; forming the grooves to receive the heads; and putting together.

Perhaps the most complete system of cask-making machinery is that of Mr. Grist, recently patented. It comprises several highly ingenious pieces of apparatus. One is a machine for bending wood to form the staves. The piece of wood to be bent is first saturated with hot water or steam, and is then placed upon the outside of a hollow metal case, shaped exactly as the stave is intended to be shaped; the case is made hot, and a lever, pressing on the piece of wood, keeps it in position until it has permanently acquired the desired form. A second machine gives the proper shape to the edges of the staves. Each stave is held firmly in a frame, and is urged forward at a particular angle to meet a saw and a cutter; the saw cuts the edges of the stave to a right line, and at the proper angle for the radius of the cask, and after this the cutter smoothes or planes each edge. A third machine builds up the staves into the form of a cask. A framework is built up of wood, corresponding on its exterior with the intended dimensions of the cask, or rather, having an expanding and contracting power, to suit it for casks of different dimensions. The staves are placed against this frame, and held there temporarily; after which, truss hoops are fixed on, and the frame and belts removed. A fourth machine performs the operations of chiming and creuzing. The cask, or rather the stave-work which is to form its principal part, is made to rotate horizontally in a lathe, while cutting-chisels or other tools trim the ends in the modes which coopers call chiming and creuzing, to enable the staves to fit into the two ends of the cask. A fifth machine cuts the ends or heads of the casks. The pieces of wood to form the heads and bottom are placed together, and brought under the action of a circular saw, which gives the requisite circular form, and at the same time gives the bevel for adjusting the head to the staves; by a slight adjustment of the mechanism, the head may be made oval instead of round. With two of the shaping machines, one man can shape the edges of the staves for a hundred hogsheads in a day.

Many modes are adopted for cleansing casks which have become foul. They are washed with dilute sulphuric acid, or with a solution of chloride of lime; or are exposed to the mingled fumes of sulphur and saltpetre; or are whitewashed with fresh milk of lime; or are charred by a fire of shavings; or are affected with a sort of charring action by very strong sulphuric acid applied to the wood when perfectly dry; or are exposed to high-pressure steam; or are filled with a mixture of charcoal and water, frequently agitated; or are soaked with a lye of pearlash, lime, or alum. After any of these processes the casks require to be well rinsed with cold clear water.

COORDINATES mean lines, angles, &c. ranged in order. The notion from which the word arose was this, that when the positions of consecutive points on a curve are referred to given points or lines by means of lines (as in ABSCISSA) or angles, those lines or angles present a succession of *arranged* data, by which the several points of the curve may be treated *in order*. It was Descartes who first used coordinates in the second book of his geometry, and the words in which this now all-pervading method of expression was announced are as follows:—"Eligo rectam aliquam lineam, veluti A B, ut ad diversa ejus puncta referam omnia puncta hujus curvæ lineæ C E; deinde eligo etiam punctum aliquod in A B, veluti A, ad *ordiendum* ab eo calculum." We do not find the word in Schooten, Beaune, or others of the immediate school of Descartes. De Witt calls the abscissa *crus patiens*, and the ordinate *crus efficiens*. Coordinates (so called) are used in the writings of John Bernoulli, but in Newton the phrase for them is "lineæ ordinatim applicatæ:" in later times the use of the word has become universal. Coordinates either determine the position of a point in space, or in a plane which is understood to contain all the figure under consideration, as in the first six books of Euclid. They determine position either by straight lines only, or by a straight line and angles: in the latter case they are called *polar* coordinates.

1. Rectilinear coordinates in a plane. In the given plane draw two straight lines meeting in a point O (called the *origin*). From any point P draw parallels to the two lines just named: the parts intercepted between P and these lines (called *axes*) are the coordinates of the point. When the axes are at right angles, the coordinates are said to be *rectangular;* when at another angle, *oblique*. [ABSCISSA.]

2. Rectilinear coordinates in space. Through any point O (the origin) draw three planes which intersect in right angles (the axes). Through any point P draw parallels to the axes: the parts intercepted between P and the coordinate planes (three in number) are the coordinates of P.

3. Polar coordinates in a plane. Choose any point O in the plane, and any right line O A passing through O. Then taking any point P, the distance O P (called the *radius vector*) and the angle P O A (which has no distinct name, but might be called the *vectorial* angle) are the polar coordinates of P.

4. Polar coordinates in space. Choose a plane (M), a point O, and a line O A, in the plane M. Take any point P above or below the plane, and let fall P B, a perpendicular on (M) meeting (M) in B. Then the radius vector O P, and the angles P O B and B O A are the polar coordinates of P. In astronomy, if O be the earth's centre, O A the line passing through the equinox, and (M) the plane of the ecliptic; then B O A is the longitude of P, and P O B its latitude. But if (M) be the plane of the equator, then B O A is the right ascension of P, and P O B its declination.

COPAIBA or COPAIVA, an oleo-resin or turpentine (incorrectly termed a balsam, since it is destitute of benzoic or cinnamic acid), is procured not merely from the *Copaifera officinalis* (Willd.), a native of Venezuela, also naturalised in the Antilles, but from ten to twelve species, chiefly natives of Brazil. It varies in appearance and qualities according to the species from which it has been procured, and likewise according to the age of the tree and the time of the year. Incisions are made in the tree, from which flows a liquid differing little in consistence from thick sap. It is collected in calabashes, after which the incisions are closed with wax or clay. The incisions are repeated in general three times each season. The fluid is brighter or darker in colour, more or less rich in volatile oil, more acrid or more bitter, according to circumstances. It is mostly of a light yellow colour, clear and transparent, seldom turbid or cloudy; odour peculiar, volatile; taste oily, mild, slightly aromatic, at last acridly bitter. Specific gravity 0·966 to 0·997, according to its age. Exposed to heat in a platinum spoon, it is entirely consumed with a white smoke. In a state of purity, it consists of a volatile oil, in the proportion of 40 per cent., and 50 per cent. of an acid crystallisable resin (copaivic acid), with a soft brown resin. The oil may be separated by distillation, or by means of mixing equal parts of copaiba with alcohol of specific gravity 0·837, shaking them diligently, then mixing 100 parts of the copaiva which has been so treated with 37½ parts of a ley of caustic soda, to be again well shaken; after which 150 parts of water are to be thoroughly agitated with it, and the whole left to rest. The specific gravity of the oil thus obtained is 0·900. A slight difference exists between the oil thus procured and that by distillation. Both are used in medicine; indeed the oil is the active principle of copaiva, the resin being of very secondary importance. The oil is destitute of oxygen, and may be employed for the preservation of potassium.

Copaiva is frequently adulterated: the presence of any extraneous matters may be known by the manner in which the suspected portion conducts itself towards solvents and re-agents. Copaiva is occasionally mixed with castor-oil, almond, poppy, nut-oil, and the finer sorts of turpentines. All fixed oils (except castor-oil, the presence of which may be detected by sulphuric acid, but the accuracy of this test is called in question by Brandes) separate from it by being allowed to remain at rest. Good copaiva should be perfectly soluble in alcohol of 90 per cent. It is soluble in all known ethers, and in the volatile and fixed oils. Three parts of copaiva with one of caustic ammonia of specific gravity 0·950 form by agitation a clear soap. The simplest test of the purity of copaiva is to heat a small quantity in a watch-glass, when, if good, a hard brittle resin remains, which has considerable analogy with styracin. The crystals which form in this resin are six-sided prisms, and have the property of polarising light.

A kind of copaiva is obtained in St. Domingo from the *Croton origanifolius* (Lamarck); in Java and elsewhere the juice of the *Canarium commune* (Linn.) is found to possess similar properties. A wood oil from various species of *Dipterocarpus*, especially *D. turbinatus*, is obtained in Moulmein, in the East Indies, and imported into England (Royle).

Copaiva acts as a stimulant to the mucous surfaces, especially of the rectum and urino-genital passages: when the dose is small, it influences the kidney and urethra; but if large, the rectum. It is chiefly used to lessen increased discharges from those organs, and if judiciously employed, generally effects this object; but if given prematurely or in too large a dose, it seldom fails to aggravate the complaints and occasion other serious symptoms. It has likewise been beneficially given in affections of the mucous membrane of the lungs, such as chronic bronchitis, which must be carefully distinguished from true phthisis pulmonalis or consumption, a disease in which it cannot fail to prove injurious. It sometimes occasions a singular eruption, something like measles, and also a swelling of the joints resembling rheumatism.

Various means have been devised to conceal the disagreeable nauseous taste of copaiva without impairing its qualities. Calcined magnesia thickens it, and permits it being made into pills; an etherial or alkaline solution will also retain the virtues, and lessen the repulsive taste.

COPAIVIC ACID. [BALSAMS.]

COPAL, a resin possessed of peculiar properties, the produce of the *Rhus copallinum*, a native of Mexico; it is in rounded masses, smooth and brittle, transparent or nearly so, without colour, or having a slight tinge of yellow: it has but little taste, and is nearly inodorous; it is insoluble in water, fusible, and inflammable. It differs from most other resins in its very sparing solubility in alcohol; and of the little that dissolves with the assistance of heat the greater part is deposited as the solution cools. It is dissolved by ether and some essential oils.

COPAL VARNISH is the substance for which gum copal is chiefly employed. It is probable that every manufacturer has his peculiar mode of proceeding: Tingry prepares the simple copal varnish by heating eight ounces of oil of turpentine in a matrass with the heat of a salt-water bath; as soon as this reaches its boiling point, he gradually throws in an ounce and a half of copal reduced to powder, keeping the vessel in a state of circular motion. This author further states that to obtain this varnish colourless, the rectified oil is to be exposed previously to the sun for some months in bottles, leaving an interval of some inches between the cork and the surface of the liquid; by this the oil undergoes some change, which renders it a better solvent of copal.

The varnish thus prepared is stated to be exceedingly durable and brilliant; it resists scratches, and is susceptible of a fine polish. Tingry particularly recommends it to be applied to philosophical instruments. There are several modifications of this varnish used for particular purposes, as with the addition of oil of lavender and oil of lavender and camphor, an account of which may be seen in the author above named.

The relation which copal bears to other varnishes will be pointed out in a later article. [VARNISHES.]

COPARCENERS. [PARCENERS.]

COPERNICAN SYSTEM. [COPERNICUS in BIOG. DIV.]

COPING, the stone, brick, or plaster cap or covering of a wall, a term perhaps derived from the Italian *coprire*, to cover. Some think it is derived from the German *kopf*, or Dutch *kop*, the head. Coping-stones are placed on the tops of walls to protect them from the weather. Flat coping is called *parallel coping*, and is used upon inclined surfaces, as on the gables and parapets of houses, and also on the tops of garden and other walls. *Feather-edged* coping has one edge thinner than the other. *Saddle-back* coping is thicker in the middle than at the edges. Coping-stones should project over the walls which they cover, and should have a groove or *throating* underneath the projected part to throw off the water. The coping of Gothic battlements and the walls of churches, castles, and dwellings in Gothic architecture, have a deep throating in the form of a bold cavetto in front, and are sometimes decorated with mouldings. [BATTLEMENT.] When the ends of the stones are left higher than other parts, the junctions are called *water-joints*. York stone is much used for parallel coping, and also Portland, but the latter is more expensive and not so durable. Bath stone coping is often used for Gothic works, but it is not calculated to withstand long the constant action of the weather.

COPPER. A well-known metal. It is an element, and is represented by the symbol Cu, an abbreviation of its Latin name *cuprum*.

Copper has been known from the earliest historical ages. It derives its present name from that of the island of Cyprus (*Κύπρος*) where it was first worked on a large scale. The alchymists called it *Venus*, perhaps on account of the beauty of its lustre, and gave it the symbol ♀, a compound hieroglyphic indicating that they thought it a mixture of gold, ☉ and a certain hypothetical substance called acrimony ✠, the corrosive nature of which was symbolised by the points of a Maltese cross.

Copper occurs native, and as the base of numerous ores. Its mineralogy has already been treated of and the ores described in detail, under COPPER, in NAT. HIST. DIV. The source of commercial copper is principally *copper pyrites*, a double sulphide of copper and iron (Cu_2S, Fe_2S_3). It occurs abundantly in Cornwall, two-thirds of the copper annually smelted in Great Britain, having a value of nearly one million sterling, being obtained from the ore raised in that county. More valuable but far less abundant ores are the *red oxide* (Cu_2O), *black oxide* (CuO), *malachite* a green carbonate, and *azurite* a blue carbonate.

The metallurgy of copper or copper smelting, is a branch of manufacture extensively conducted in the neighbourhood of Swansea, South Wales, a locality peculiarly fitted for the operation on account of its proximity to the coal-fields, and its position as a sea-coast town; these advantages at all times insuring cheap fuel and cheap freightage to the different metallurgical establishments.

The ore of copper as raised from the mine is first cleaned from adhering portions of the strata through which the vein passed, then sorted according to quality, so far as appearance indicates, and placed in heaps of convenient size for sale. To ascertain the value of a heap, a fair average sample is taken, and about four hundred grains of it assayed by roasting, fluxing with borax, reducing with black flux, &c., according to the nature of the ore: or a weighed quantity may be dissolved in nitric acid, excess of ammonia added, the mixture filtered, boiled with caustic potash or soda, and the resulting oxide collected on a filter, washed, dried, ignited, and weighed; 100 parts will contain 79·82 of copper. As both the composition of copper ore and its richness in metal are liable to great variation, the methods of smelting are necessarily complicated in order that these variations may be met. The process, however, on which the modifications are all based, is a very simple one. It consists first in roasting the ore on the hearth of a powerful reverberatory furnace; any arsenic is thus driven off, whilst a portion of the sulphur is converted into sulphurous acid and escapes, oxygen taking its place. The iron present in the ore, however, has a greater affinity for oxygen than the copper has, and hence the sulphide of iron will be decomposed before the sulphide of copper. As soon as the sulphide of iron is thus oxidised the roasting is discontinued, and the oxide of iron removed by fusion with sand or siliceous ore, and sometimes a little fluor spar. The sulphide of copper is now partially roasted into oxide and then fused, when an interesting reaction occurs, the sulphide and oxide mutually decompose each other, sulphurous acid escapes and metallic copper remains; the decomposition is expressed in the following equation:—

$$\underbrace{CuS}_{\text{Sulphide of copper.}} + \underbrace{2CuO}_{\text{Oxide of copper.}} = \underbrace{SO_2}_{\text{Sulphurous acid.}} + \underbrace{Cu_3}_{\text{Metallic copper.}}$$

The metal thus produced is again roasted to remove the last traces of foreign matters, and is finally thoroughly deoxidised by heating with carbonaceous materials, and especially by the operation of *poling*; in which a pole of green wood, generally birch, is thrust into the molten metal and rapidly moved about; the powerfully deoxidising gases given off from the wood effectually reduce the oxide, and when a small sample taken from the mass, and tested when cold by partially cutting through and then breaking, presents a fine fibrous fracture and a satiny lustre, the operation is considered to be complete, and the metal is at once ladled out and cast into ingots. Great care and considerable experience are necessary to detect with certainty this latter point, as a few minutes *overpoling* would determine the formation of carburet of copper; and this would render the whole mass brittle and necessitate re-roasting.

Such is an outline of copper smelting. For an elaborate description of it in all its details, see Muspratt's 'Chemistry, applied to the Arts and Manufactures,' pp. 493 to 532.

Perfectly pure metallic copper may be obtained on the small scale by decomposing a solution of sulphate of copper by means of the voltaic battery, or by inserting strips of iron into the same solution; in the latter case the precipitated metal is called *cement copper*. Another method consists in strongly heating six parts by weight of the pure oxide with one part of finely powdered charcoal and a little borax; in this way a button is at once obtained. Copper in a state of fine division results, when a current of hydrogen gas is passed through the pure oxide heated to redness.

Copper has a characteristic red colour; very thin films of it however, such as are frequently obtained by the chemist in analysing organic substances by the aid of black oxide of copper, appear by transmitted light of a beautiful green colour, though by reflected light they also have the usual tint. Copper is rather hard, sonorous, and exceedingly ductile and malleable. Its specific gravity varies from 8·78 to 8·96, according to the manipulation to which it has been subjected; it is one of the best conductors of heat and electricity, and expands one part in 582 on being heated from 32° Fahr. to 212°. Copper crystallised in the form of cubes or octohedra is occasionally found native. It may be obtained in the same state artificially by slow voltaic action. The melting point of this metal is under that of gold, but higher than silver; in the fused state it exhibits a bluish-green colour, and at an intense white heat, such as is produced by a powerful electric current, or the oxyhydrogen blowpipe, it boils, burns with a green flame, and is entirely volatilised.

Copper does not tarnish on being exposed to dry air, but in the presence of moisture and carbonic acid, it gradually becomes covered with a greenish coating of oxide and carbonate. Nitric acid rapidly attacks and oxidises copper, forming a nitrate of copper. Sulphuric acid does not act upon it when cold, but at a boiling temperature oxidises it with evolution of sulphurous acid and formation of sulphate of copper. Hydrochloric acid acts only on copper in the presence of oxidising agents. The fixed alkalies act but little on the metal, ammonia in the presence of a small quantity of air gradually dissolves it, forming a colourless solution of suboxide; more air causes the formation of a deep blue solution of protoxide. Copper has a nauseous styptic taste, and on being rubbed emits a peculiar disagreeable odour.

The equivalent of copper is 31·75.

Copper and *oxygen* unite in four different proportions:—

	Formula.	Equivalent.
Suboxide of copper	Cu_2O	71·5
Protoxide of copper	$Cu\ O$	39·7
Binoxide of copper	$Cu\ O_2$ (?)	
Cupric acid	(?)	

1. *Suboxide of copper* (Cu_2O); *cuprous oxide, dinoxide*, or *red oxide of copper*. This oxide occurs native in the form of beautiful red crystals. It is best prepared artificially by heating a solution of sulphate of copper with excess of caustic potash or soda and a little honey, the suboxide deposits in the form of bright red granular crystals.

The salts of this oxide are very unstable, and consequently difficult of preparation.

Sulphite of cuprous oxide and potash is formed by gradually adding solution of sulphate of copper to a hot solution of sulphite of potash; on cooling the salt deposits in crystalline needles. The principal use of suboxide of copper is in the staining of glass, to which it communicates a ruby-red colour.

2. *Protoxide of copper* (CuO), *black oxide*, or *cupric oxide*, prepared either by heating copper-plates and turnings in a current of air, or from the nitrate of copper, by heating that salt to redness in an earthen crucible. By the former method it is obtained more or less massive and crystalline, by the latter in the state of fine powder. In either condition it is used to some extent by chemists in the analysis of organic substances. [ORGANIC ANALYSIS.] It is also used to stain glass of a beautiful green colour.

The salts of protoxide of copper are numerous, well-defined, and important. The following are the principal of them.

Sulphate of copper (CuO, $SO_3 + 5$ Aq.), equiv. 124·7, *blue vitriol*. This salt occurs native, see BROCHANTITE, NAT. HIST. DIV. It is obtained as a by-product in silver refining; also in large quantities in the roasting of copper pyrites at a temperature approaching low redness; this heat is sufficient to decompose the sulphate of iron formed at the same time, but is not high enough to affect the sulphate of copper. It is purified by crystallisation from a hot aqueous solution. It may also be formed by boiling copper with three times its weight of strong sulphuric acid, diluted with one-third its weight of water; the copper is oxidised at the expense of part of the sulphuric acid, and combines with the remainder. Commercial sulphate of copper is, however, principally manufactured by simply dissolving the crude oxide or scale in sulphuric acid with the aid of heat. The scale is obtained by roasting waste copper, and in the process of annealing copper-plates; it consists of a mixture of metallic copper with oxide.

Sulphate of copper crystallises in large blue crystals of an oblique rhombic form. It is soluble in two parts of boiling water, from which solution one half of the salt crystallises out on cooling. Heated, it loses its water of crystallisation, assumes a white colour, and at a higher temperature is decomposed, the acid being expelled and the oxide left.

Sulphate of copper is largely used in calico-printing, and in the manufacture of pigments. Large quantities of it are also employed in agricultural districts to steep seed-corn in, it being found that this is an effectual remedy against the disease in wheat called "smut." For the latter purpose, however, a very impure sulphate of copper is frequently used; obtained by evaporating the Birmingham "pickle," or "dipping liquor," of the brazier and coppersmith. This liquor is an acid solution into which manufactured brass articles have been dipped in order to render them perfectly clean before lacquering, varnishing, &c. The sulphate thus obtained costs some shillings less per cwt. than the purer variety, but more of it must be used to produce the desired effect.

Double sulphates of copper and alkali, are obtained by evaporating a solution containing equivalent proportions of the separate sulphates. The potash salt contains ($CuO, SO_3 + KO, SO_3 + 6\,Aq.$) the ammonia salt ($CuO, SO_3 + NH_4O, SO_3 + 6\,Aq.$), the soda salt ($CuO, SO_3 + NaO, SO_3 + 2\,Aq.$); the latter is rather difficult to prepare. Double salts may also be formed with the sulphates of several other metals.

Ammonio-sulphate of copper ($CuO, SO_3 + 2\,NH_3 + HO$) separates in dark blue crystals on cautiously evaporating a solution of sulphate of copper to which excess of ammonia has been added. Anhydrous sulphate of copper absorbs ammoniacal gas, yielding a compound consisting of ($2(CuO, SO_3) + 5\,NH_3$).

Nitrate of copper ($CuO, NO_5 + 6\,Aq.$). Prepared by dissolving copper in nitric acid; the following decomposition occurs:—

$$\underbrace{\mathrm{Cu_3}}_{\text{Copper.}} + \underbrace{\mathrm{4NO_5}}_{\text{Nitric acid.}} = \underbrace{\mathrm{3(CuO, NO_5)}}_{\text{Nitrate of copper.}} + \underbrace{\mathrm{NO_2}}_{\text{Nitric oxide.}}$$

By evaporation of the solution it is obtained in beautiful blue rhomboidal prisms. They rapidly deliquesce in the air, and are very soluble in water or alcohol.

Carbonate of copper is not known in the neutral state. Associated with hydrated oxide it occurs native. [COPPER, in NAT. HIST. DIV.] When solutions of a salt of copper and an alkaline carbonate are mixed, a bulky, gelatinous, green precipitate falls, usually having the composition ($CuO, CO_2 + CuO, HO$). Under various names it is used as a pigment. [COLOURING MATTERS.] Mixed with lime and exposed to the air its colour is changed to blue.

Acetate of copper ($CuO, C_4H_3O_3 + HO$), *verditer*. Prepared by dissolving oxide or subacetate of copper in acetic acid and evaporating the solution. It crystallises in oblique rhombic prisms, and is soluble in five parts of boiling water.

Subacetates of copper. [ACETATE, *Diacetate of Copper*.]

Arsenite of copper ($2CuO, AsO_3$); *Scheele's green*. Precipitated on mixing solutions of arsenite of potash and sulphate of copper. It is extensively used as a pigment. If acetate of copper be employed in the place of sulphate the precipitate contains ($CuO, C_4H_3O_3 + 3(2CuO, AsO_3)$), and is known as *Schweinfurth green*. The different *arsenical greens*, as these pigments are called, owe their different tints to the various proportions of acetate and arsenite of copper contained in them, and also occasionally to the presence of carbonate of copper. [COLOURING MATTERS.]

Protoxide of copper combines with many other acids, but the compounds formed are comparatively unimportant.

Hydrated protoxide of copper (CuO, HO) is precipitated when an alkali is added to an aqueous solution of any copper salt.

3. *Binoxide of copper* (CuO_2)? is a brownish-yellow powder, formed on treating hydrated protoxide of copper with peroxide of hydrogen. At a slightly elevated temperature it loses one half of its oxygen. On account of its liability to change it has been but little studied.

4. *Cupric acid?* said to contain more oxygen than either of the preceding oxides, is supposed to be formed when finely divided copper, caustic potash, and nitrate of potash are together heated to redness. Digested in water, the mass yields a blue solution that disengages oxygen on being slightly warmed.

Copper and *hydrogen* form

Hydride of copper (Cu_2H). It is obtained as a brown hydrate, very unstable, when hypophosphorous acid is added to a solution of sulphate of copper heated to 140° Fahr.

Copper and *nitrogen* form

Nitride of copper (Cu_3N). Obtained on passing ammoniacal gas over oxide of copper heated in an oil-bath.

Copper and *sulphur* form two sulphides.

Disulphide of copper (Cu_2S) is produced when copper is burnt in vapour of sulphur. It melts more readily than metallic copper, and forms a semi-crystalline mass on cooling.

Protosulphide of copper (CuS) is precipitated of a black colour when sulphuretted hydrogen is passed through a solution of a copper salt. Washed and dried, it presents a very dark green appearance.

Double sulphides of copper and other metals are found native. [COPPER, NAT. HIST. DIV.]

Copper and *chlorine* form two chlorides, corresponding to the oxides and sulphides.

Dichloride of copper (Cu_2Cl), Boyle's *resina cupri*, is obtained in transparent tetrahedra on boiling the protochloride and metallic copper together in close vessels. Heated it fuses and then volatilises. In contact with air it quickly absorbs oxygen. It is but little soluble in water. Its aqueous solution is used in gas-analyses for the absorption of carbonic oxide.

Protochloride of copper ($CuCl + 2Aq.$) is most easily formed by dissolving the oxide or carbonate in hydrochloric acid. On evaporation transparent, bright green, right-angled four-sided prisms are obtained. They are very deliquescent.

Oxychlorides of copper, of variable composition, are obtained on precipitating chloride of copper with a caustic alkali.

Double chloride of copper and ammonium ($CuCl, NH_4Cl + 2Aq.$) crystallises on the cooling of a solution of the mixed chlorides in equivalent proportions.

Cuprammonium, in the state of *chloride*, is by Graham and Kane considered to be the true constitution of a compound containing (H_3NClCu), obtained on passing ammoniacal gas (NH_3) over chloride of copper heated to a temperature of about 400°. They regard this salt as simply chloride of ammonium (NH_4Cl), in which one equivalent of hydrogen is replaced by an equivalent of copper.

Copper and *iodine* form only one compound,

Diniodide of copper (Cu_2I). A light brown powder, precipitated on mixing together solutions of sulphate of copper, sulphate of iron, and iodide of potassium—

$$\underbrace{\mathrm{2(CuO, SO_3)}}_{\substack{\text{Sulphate of}\\ \text{copper.}}} + \underbrace{\mathrm{2(FeO, SO_3)}}_{\substack{\text{Protosulphate}\\ \text{of iron.}}} + \mathrm{KI} = \underbrace{\mathrm{KO, SO_3}}_{\substack{\text{Sulphate of}\\ \text{potash.}}} + \underbrace{\mathrm{Fe_2O_3, 3SO_3}}_{\substack{\text{Sesquisulphate}\\ \text{of iron.}}} + \underbrace{\mathrm{Cu_2I}}_{\substack{\text{Diniodide}\\ \text{of copper}}}$$

Copper and *bromine* form two bromides,

Dibromide of copper (Cu_2Br) is produced when metallic copper is heated in vapour of bromine.

Protobromide of copper ($CuBr$) is obtained in crystals somewhat resembling iodine in appearance, on evaporating in vacuo a solution of hydrated protoxide of copper in aqueous hydrobromic acid.

Copper and *cyanogen* combine to form two simple cyanides,

Dicyanide of copper (Cu_2Cy) falls as a white powder on adding cyanide of potassium to a solution of dichloride of copper in a little hydrochloric acid. It is soluble in ammonia, dilute acids, and alkaline cyanides.

Protocyanide of copper ($CuCy$). A brownish-yellow compound, precipitated on mixing solutions of sulphate of copper and cyanide of potassium. It is very unstable.

Double cyanides of copper and other metals, or *cuprocyanides*, are described under CYANOGEN.

Alloys of copper. [ALLOY; BRASS; BRITANNIA METAL; BRONZE; GERMAN SILVER.]

Tests for the Salts of Copper.—The most characteristic are the following: *Ammonia* in excess forms a dark blue solution. *Ferrocyanide of potassium* yields a fine red-brown precipitate. A strip of bright *metallic iron*, in a slightly acid solution of a copper salt, has, after a short time, copper deposited on it with characteristic colour. *Before the blowpipe*, on a charcoal support, copper compounds furnish in the reducing flame, with carbonate of soda, a bead of metal recognised as copper by its colour.

Estimation of Copper.—In addition to the processes, for the quantitative determination of copper, mentioned at the commencement of this article, the following volumetric method is recommended by Mr. E. O. Brown: Ten grains of the matter under examination are placed in a half-pint flask and dissolved in boiling diluted nitric acid; carbonate of soda is then added till a precipitate is formed, and lastly, excess of acetic acid. About sixty grains of iodide of potassium are now introduced, and sufficient time having been allowed to elapse for the crystals to dissolve, a standard solution of hyposulphate of soda is poured in from a burette till the brown liquid assumes a yellow colour. A little clear solution of starch is then added, and the addition of the hyposulphite of soda continued until the blue iodide of starch has entirely disappeared.

In the above process care should be taken that the iodide of potassium is free from iodate of potash, and that the acetic acid contains no sulphurous acid. The solution of starch should be dilute and rendered clear by standing. The solution of hyposulphite of soda is made by dissolving 4000 grains of the salt in two gallons of water, and standardising by means of electrotyped copper.

COPPER, in a metallic state, produces no action on the human system. When in the form of oxide its action is considerable, though variable, being dependent on the kind and quantity of acid which it may meet with in the stomach; but all its salts occasion peculiar effects, which may be fatal if the dose be large. It is not necessary that the substance should be introduced into the stomach, for the salts of copper act in whatever way they are introduced into the system, and the more energetically the more directly they enter the blood. The greater the degree of solubility, the more rapidly are the formidable symptoms displayed. The chief preparations of copper used in medicine are, the sulphate, or blue vitriol, called also blue-stone; the ammoniated sulphate or ammoniuret; and the diacetate, or verdigris. The two former are used internally, the latter externally; it and the sulphate being applied by surgeons to wounds and sores in particular states.

Sulphate of copper influences powerfully the nervous system, and acts as a tonic and antispasmodic; it has also some astringent properties. Nevertheless, it often promotes free secretion of saliva, which renders it an eligible tonic in some forms of dyspepsia, with depressed nervous power, when a dry condition of the mouth and throat exists, particularly in the morning. It is often available in such cases when mercury is inadmissible. The presence of a minute quantity of copper in Saidschutz water may render that spring a preferable place of resort for dyspeptics in whom torpor of the liver prevails. In a considerable dose the sulphate causes vomiting; in still larger doses it causes purging, accompanied with tenesmus, followed by convulsive agitation of the head, or rigidity amounting to tetanic, laborious respiration, pain and tightness of the head, insensibility, lethargy, and speedy death. In some instances the narcotic symptoms are the first to be displayed, those of irritation succeeding; jaundice, if the patient survive, or yellowness of the corpse, is no uncommon occurrence,—a fact to be borne in mind as a distinctive mark of poisoning by copper among metals: the same sign however occurs in poisoning from aconite, and most ranunculaceous plants. If the effect of the poison when copper has been taken has been speedy, few traces of morbid action are found in the intestinal canal; and "too much reliance ought not to be placed on mere bluish or greenish colouring of the membranes of the stomach; for Orfila and Guersent have both observed that the inside of the stomach, as well as its contents, may acquire these tints in a very remarkable degree in consequence of natural disease." (Christison.)

In cases of slow poisoning by copper, such as happen when some of its salts in substance or solution have been taken daily for a considerable time, fatal results follow, and the copper may be detected accumulated in the liver, though not discoverable in any other organ of the body. The circumstances of the copper being carried to the liver explains the frequent occurrence of jaundice, as stated above.

In small medicinal doses, sulphate of copper has been employed in diarrhœa, which, when chronic, it often checks; even in Asiatic cholera it has proved useful. Indeed it seems to check augmented secretion from all mucous surfaces, on which account it may be used in chronic discharges from the urino-genital organs, and also of the lungs, to benefit which last organ it is usually given as an emetic. It may likewise be employed as an emetic in cases of poisoning by narcotic agents, in preference to tartrate of antimony or ipecacuanha, as its action is not preceded by nausea, which promotes the absorption of the poisonous agent.

Its chief internal use, however, is as a tonic and antispasmodic, in many convulsive and nervous diseases, such as epilepsy and chorea. In these last-named diseases the ammoniacal sulphate is often to be preferred, given in the form of pill. Sulphate of copper is, however, in most frequent use by surgeons as an external application to wounds when indolent, or filled with the unhealthy kind of granulations termed "proud flesh." It is similarly used in some forms of ophthalmia, especially of the inner surfaces of the eyelids. Small ulcers of the gums readily heal by touching them with the *Mel ægyptiacum*, a solution of sulphate of copper in honey.

Diacetate of copper is rarely given internally; but it is the frequent source of accidental or intentional poisoning, when its general effects are nearly the same as those of the sulphate. In the form of a liniment, it is of great utility in certain affections of the mouth and gums, applied by means of a camel's-hair brush. Likewise as an ointment to stimulate old and indolent ulcers, it is superior to all other means.

Poison often results from the formation of verdigris in copper vessels used in cooking, or the more reprehensible practice of putting copper coins into pickles to make them a fine green colour. It seems that copper vessels, if kept clean, are not dangerous, provided whatever is boiled in them (unless of an acid nature, which will always form some dangerous compound) be not allowed to stand to cool in the vessel, but be instantly poured out. Tinning the interior of copper vessels affords protection so long as the tinning remains entire. In case of poisoning, the best antidotes are whites of eggs, milk, or wheat flour; ferrocyanate of potass, or iron filings, in gum-water, may be given; sugar or any syrup is useful. But liver of sulphur should never be given, and least of all should vinegar.

COPPER, ALLOYS OF. [Copper.]

COPPER MANUFACTURE. In the article above the processes are noticed of smelting and refining copper, whether it be intended for the manufacture of brass, or rolling into sheets. Here we shall briefly notice some of the subsequent processes in the manufacture of copper goods. It may be well first, however, to notice one or two additional matters relating incidentally to the smelting.

Great Britain is not so rich in copper as to give it a leading position among copper-producing countries; it is the advantage of cheap fuel, and the skill obtained by our smelters, that render the operations in Cornwall and Wales so important. It is also observable that France and Belgium are almost destitute of copper-mines; so that the English have an opening in those countries for manufactured copper, and can compete in Central Europe with Russian copper. It has sometimes been feared that the large supplies of copper from Chili, the United States, and Australia, will by-and-by affect injuriously the Cornish interest; but, on the other hand, if processes be adopted for the more economical reduction of copper, ores of two qualities could then be brought into the market. South Wales, although not yet materially threatened, is beginning to feel the effects of competition further north. Liverpool, having a great import of foreign and colonial copper ores and bar copper, is favouring the establishment of smelting-works on the Mersey; and now that great port has a copper-market which is growing yearly in importance. Many of the South Wales smelters from time to time bring forward improvements in their art; one, for instance, is that of Mr. Parkes, relating to processes for obtaining superior copper from inferior ores, by adding a little iron or zinc, which is afterwards driven off. The ore is smelted as usual, so far as the roasting process; the ore is then allowed to cool; one cwt. of iron is thrown in to 50 cwt. of regulus; the furnace-doors are closed; the whole is heated up to the degree of pimpled copper, and then tapped. Mr. Parkes also has a process for the treatment of argentiferous copper-ore, depending on the fact that silver may be volatilised by applying heat when in combination with metallic zinc and arsenic.

Leaving any further details untouched in this article, we proceed to notice the modes of fabricating sheet and bar copper into useful articles.

The principal peculiarity in the manufacture of this metal arises from the facility with which it may be fashioned by the hammer. The processes of casting and rolling, both of which are extensively practised in the manufacture of copper goods, so closely resemble the like operations upon other metals, that they do not require further notice; but the operations of the copper-smith are very distinct from any other branch of metallic manufactures. One of the best examples, perhaps, of manufactures in copper, is presented in the large pans for boiling sugar in vacuo; and this we may take to illustrate the successive processes. Each of these pans consists of a circular domed vessel, with several apertures for valves, gauges, &c., and a spiral coil of copper pipe within the lower part. The top and bottom of this vessel, which are of similar shape, both being convex externally, are formed of one piece each, in the following manner: The copper is in the first place cast into a form resembling that of a double convex lens, thickest in the middle, and diminishing gradually towards the edges. This lens is then subjected to the powerful blows of a tilt-hammer, directed more continuously near the centre than near the edges. A little consideration will show that this hammering, while it reduces the thickness of the copper, must make it curl up at the edges, or assume a dished or hollow form: we find that this is the case even when a flat piece of metal is hammered at its centre, and still more does this result ensue when an increased substance is given to the centre. The thickness of the centre is so adjusted as to afford metal enough for the curvature of the vessel, and the hammering is continued till the thickness of the whole is brought nearly uniform. This is a very important process, since the fitness of the vessel for the operations of the sugar-refinery depends on the soundness and perfection of the metal. Sometimes a piece of copper, dished or hollowed in this way, and worth forty guineas in material and labour, if sound, is rendered useless by a flaw in the metal.

The above description will indicate the mode in which many curved articles of copper receive their shape. Another process no less peculiar to the manufacture is the hammering, technically called *planishing*, by which the metal is rendered dense and firm, and its toughness is increased,—a process of so deafening a nature as to impart a singular character to a coppersmith's establishment. This operation presents something of the picturesque effect formerly observable in anchor-smitheries, when Nasmyth's hammer had not yet superseded the ordinary hammers: six or eight men, standing in a circle round the piece of copper, and each wielding a heavy hammer, strike the metal in succession, every part of the surface receiving probably as many as ten or twelve blows. Any one who examines a large copper vessel will perceive, both in the hammer-marks and in the density and close grain of the surface, evidences of the planishing process.

By these two processes of hammering, the first to beat the copper into the required shape, and the second to condense and harden the surface when the shaping is completed, many articles which it might seem difficult to form without numerous joints are fashioned, often from masses of cast metal formed originally in a very different shape, or very much smaller and thicker than the finished articles are intended to be. In many cases, however, the hardness occasioned by the hammering impedes the shaping process, and must be repeatedly removed by annealing or softening by heat, to renew the malleability and extensibility of the metal. The principal component parts of a large copper vessel being thus formed, the next point which claims notice is the mode of joining them together. *Riveting* is a mode of fastening much employed for this purpose. In this process the edges of the adjoining plates are made to overlap, and holes are punched through the overlapping plates by a punching-engine, which cuts out a small circular piece equal in size to the rivet. The rivets, which may be compared to short, thick, blunt nails, are then inserted; and the smaller ends, which project through the holes, are spread out by the hammer so as to form what may be styled a second head. The edges of the sheets or plates of copper are finally *caulked*, or hammered until they close so perfectly as to form a joint impervious to water, air, or steam. Smaller copper vessels are united by soldering or brazing. Holland, in Lardner's 'Cabinet Cyclopædia,' refers to a copper tea-kettle as presenting a familiar but ingenious specimen of the coppersmith's art, both with reference to soldering and hammering. "Taken, indeed," he observes, "in all its parts, it exhibits the result of almost every operation of his workshop." To make this article a piece of sheet copper is taken, rather longer than the intended circumference of the kettle, and some inches wider than its depth. The surface of this piece of copper, for about an inch at each end, is then brightened by filing, and one end is cut into to the depth of about an inch, and at intervals of about an inch, with a pair of shears. Every alternate portion of the cut edge is then turned a little back, so that when the plate is bent round into a cylindrical shape, the uncut end may be laid between the alternate tongues or portions of the cut edge, and embraced, as it were, by them. A mixture of borax and solder is then applied to the joint, which is, after soldering, hammered upon a steel mandril or stake, until the seam becomes smooth, and is beaten down to the thickness of the adjoining portions of the plate. A perfect cylinder being thus formed, the next operation is to turn it inwards in a sloping direction for a space of about two inches, to form the top of the kettle, or that portion which extends from the shoulder at the top of the cylindrical side of the vessel to the edge of the opening to which the cover is fitted. This is done by hammering upon an anvil of suitable shape. About an inch of the lower end is then turned inward in the same way, and cut with the shears into tongues, which are bent back alternately in the same manner as those at the end of the plate had been. A piece of sheet copper cut to fit the end of the cylinder, so as to form the bottom of the kettle, is then inserted and united to the cylinder by the same process as that described for the first joint. The vessel is then *pickled* in diluted sulphuric acid, after which it is planished to brightness, the marks of the hammer being rendered imperceptible by the intervention of a piece of old moreen, or other woollen stuff, between the surface of the copper and the stake or anvil on which it is laid. The lid of the kettle is dished by stamping it in a die; the handle is cast; and the spout, after being soldered up and rounded a little on a mandril, is finally shaped upon lead with which it has been filled, and afterwards soldered or riveted into its place. Copper tea-urns and saucepans are formed by soldering and hammering in a similar manner, the former being in general finished with a beautiful colour, produced by the application of sulphate of copper or Roman vitriol, previous to the planishing or burnishing.

There are several different modes of forming copper piping out of sheet metal. In one of these, the edges of the sheet, which is curved round a mandril, are made to meet without overlapping, and united by hard solder; in a second, they overlap, and are united by soft solder; in a third they overlap, and are secured by rivets; in a fourth, the edges are folded together, one being bent outwards and the other brought over it and turned into the acute angle formed between the outside of the tube and the turned back edge, the whole being subsequently made close and firm by hammering; while in a fifth, both edges of the pipe are turned back and covered with a strip of sheet metal, the two edges of which are turned in like the outer edge of the joint last described. The bending of such pipes into curved forms, as for the spiral coil in the sugar-pan described above, is a curious operation. Any attempt to bend such a tube while empty would be certain to impair its shape, and would probably occasion its fracture. To obviate this difficulty the pipe is, before bending, filled with lead, or some soft metallic alloy which will melt at a temperature which will not injure the tube. Being thus filled, the pipe may be treated as a solid bar of metal, and safely bent into any required form by suitable machinery; and when the desired curvature is gained, sufficient heat is applied to cause the contained metal to melt and flow out of the pipe. A patent was taken out a few years ago, for a mode of using up old worn-out rollers, such as those employed in calico-printing. The cylinders are to be bored truly, rolled or drawn out to the form of tubing, and annealed.

The use of copper sheathing for ships, an application which occasions a very large demand for this metal, is alluded to under SHIP-BUILDING. The articles BRASS; BRONZE; and BELL-CASTING, treat of some of the most important manufactures of the alloys of copper. Of some of the minor articles of manufacture, in the composition of which copper forms a chief constituent, an account is given under BUTTON; and COCK.

We add a few words concerning the trade and statistics of copper. No effective attempt has ever been made to ascertain the actual productiveness of the mines in this country; and all that is hitherto known on the subject is derived from partial inquiries of individuals. By this means, however, a tolerably accurate account has been taken of the produce of the copper mines in Cornwall, reaching back to 1771, with the exception of a few intermediate years, the returns of which are wanting. Since 1821 similar accounts have been procured of the produce of other mines in the United Kingdom. The annual produce of the Cornish mines rose from about 3400 tons in 1771, to 5000 tons in 1800; 7000 tons in 1820; and 12,000 tons in 1835. Since the last named year the yield has not advanced in equal ratio. The total quantity of metallic copper obtained at the smelting works of England and Wales, was 14,000 tons in 1835; since which year there has been a steady increase.

The supply from South Australia is becoming important. It was in 1845 that twelve miners began operations at the Burra Burra copper-mines in that colony; in the beginning of 1859 there were more than a thousand employed, supporting a population of five thousand persons. In the intervening period of fourteen years, the Burra Burra yielded 128,000 tons of copper ore, from which 26,000 tons of metallic copper were obtained, worth from two to three millions sterling, according to the state of the market. A small portion of the produce was shipped to England in the state of ore.

During the last three years, the imports of copper ore and regulus into Great Britain have been as follows, from different countries :—

	1856.	1857.	1858.
	Tons.	Tons.	Tons.
From Spain . . .	5,692	13,030	6,122
" Cuba . . .	19,836	16,352	14,728
" Chili . . .	33,227	39,295	48,329
" Australia . . .	8,434	8,489	9,128
" All else . .	15,614	17,928	18,792
	82,803	95,094	97,099

Including copper in a partly manufactured state, the total in 1858 amounted to 128,2[illegible]0 cwts. The exports of metallic copper, in the same three years, presented the following figures :—

	1856.	1857.	1858.
	Cwt.	Cwt.	Cwt.
Brick and pig copper .	121,935	142,920	134,618
Sheet and nail copper . .	287,571	274,536	303,810
Wrought copper . .	28,716	65,419	58,114

This is irrespective of the copper contained in the articles of brass manufactured. The declared value of the copper and copper goods exported in 1858, was no less than 2,698,836*l.*, averaging about 109*s.* per cwt. British India is the largest purchaser of these goods.

COPPER-NICKEL. [NICKEL.]

COPPERAS. [IRON, *Protosulphate of.*]

COPPICE, a wood or plantation of various kinds of trees, which shoot up from the root when cut down, and which are periodically cut down before they acquire any considerable size. The most common trees planted or used for this purpose are the oak, the chestnut, the maple, the birch, the ash, and the willow. The hazel and the alder are also frequently planted in coppice, the former in dry and chalky soils, the latter in moist and marshy situations. Timber trees are generally allowed to grow in coppice, or more properly the coppice is the underwood where the timber is the principal object. There is a doubt, however, whether it is judicious to allow many trees to stand where there is a ready sale for coppice wood. The quick return of the latter overbalances the greater price of old timber. In consequence of this opinion, large trees fit for ship-building, which require a long time to arrive at the required size, are becoming scarce; and many woods, once thickly studded with majestic trees, are reduced to mere coppice wood. The value of a well-managed coppice is considerable where the produce can be readily manufactured into useful articles, and carried to a good market. Ash hoops, hop-poles, chestnut gate-hurdles, and sheep-hurdles are the principal articles manufactured or prepared in a newly-cut coppice. What is of no use for these purposes is made into faggots for fuel, where this is scarce, or converted into charcoal, which is more easily transported. A good coppice will bear to be cut down every eight or nine years, and will thus be worth, according to situation, from 6*l.* to 15*l.*, per acre, or even more, when sold to those who undertake to cut and prepare the wood.

Little attention is generally paid to the coppice, except when it is fit to be cut, but this is a great mistake: with a little attention a coppice may be doubled in value in a few years. It should be carefully drained where the water has not a ready outlet. Where the most profitable kinds of wood are deficient fresh plants should be supplied. The whole should be kept well stocked, but not overstocked; and the pruning-knife should be used where it appears necessary, especially where hop-poles are in request, which usually bear a good price Hop poles require a longer time to attain the proper size, and more room to grow. For this purpose the coppice may be thinned out, without being entirely cut down. When a coppice is cut, attention must be paid to the manner in which the poles and rods are cut off from the stem. They should be divided by a clean slanting cut with a very sharp axe or bill-hook, so as not to shatter the stump which is left. The wound will then soon heal over, and the stump will not be injured by the wet and decay, as is too often the case. When fresh ground is planted for a coppice, it should always be previously trenched and drained. The extra expense of this will soon be repaid. Scotch firs may be planted at first as nurses and shelter to the oaks and other forest trees. In seven or eight years the firs will have acquired a considerable height, and may be thinned out or cut down; they never shoot again from the root. The other trees may be left to grow a few years longer, before they are cut down. After the first cutting, attention must be paid to the stumps and all superfluous shoots removed. In seven or eight years a thick coppice will be formed, which will increase in value every time it is cut, and will produce a very good annual rent for land which might not have been profitable in cultivation, either as pasture or arable farms. The annual expense of a coppice is trifling, and the regular returns are certain and profitable. When a portion of coppice is cut every year, so as to have a regular rotation, the income is as regular as that of any other part of an estate. A proportion of coppice on an estate is essential to the production of game and to its preservation.

The ground most favourable for coppice is that which is too steep or rocky for cultivation, and where the climate will not allow of the vine. Where the land is flat, and can be well drained, arable farms will always be most profitable, unless in some poor sandy soils, where corn will not grow without extraordinary manuring, while the roots of some kinds of trees will sink to a great depth and find there the nourishment necessary to their growth. In such sandy soils the birch, the maple, and the acacia sometimes grow luxuriantly, when the grass on the surface scarcely shows signs of vegetation. On wet and boggy soils the willow and the alder are almost the only trees that will thrive. Whoever plants a coppice must be well acquainted with the soil to a considerable depth, and must choose his plants accordingly.

COPT, the name given to the Christian descendants of the ancient Egyptians. It is correctly pronounced either Ckoobt or Ckibt, and it is generally believed that the name is derived from Coptos, once a great city in Upper Egypt, now called Ckooft or Gooft, to which, during their persecution by the Roman emperors, many of the Egyptian Christians retired. We are inclined to recognise in *Copt* the main part of the ancient name of the country *Αἴγυπτος*. The name *Copts* seems to have been used as the common designation of the Christians in Egypt from the time of the Emperor Heraclius, when the patriarch Benjamin was permitted to return from his exile in the Thebais (about A.D. 644) and to resume his functions as a bishop at Alexandria. (Le Quien, 'Oriens Christianus,' ii. 481.) They are not an unmixed race, their ancestors in the earlier ages of Christianity having intermarried with Greeks, Nubians, and Abyssinians. The secession of the early Christians of Egypt from the Church of Constantinople occasioned bitter enmities to spring up between them and the Greeks, on which account they suffered so much persecution, that they united with the Arab invaders of their country to expel the Greeks; but though their revenge was gratified, they were compelled to bow to a heavier yoke. With the exception of a small proportion who profess the Romish or the Greek faith, the Copts are Christians of a sect called Jacobites, Eutychians, Monophysites, and Monothelites, whose creed was condemned by the council of Chalcedon, A.D. 451. The number of churches and convents in ruins prove that the Copts were once far more numerous than at present: they do not now compose more than one-fourteenth part of the population of Egypt, their number not exceeding 150,000, about 10,000 of whom reside at Cairo. Conversions to the Mohammedan faith, and intermarriages with the Moslems, have occasioned this decrease in their numbers; to which may be added the persecutions which they endured from their Arabic invaders and subsequent rulers. They were forced to adopt distinctions of dress, and they still wear a turban of a black or blue, or a grayish or light brown colour, in contradistinction to the red or white turban. The distinction is generally carefully observed in the towns, but less so in the villages. Under the dominion of the recent Pashas of Egypt, the Copts are not the despised race they once were: some of them have even been raised to the rank of beys. The male adults pay a tribute, besides the income tax which they pay in common with the rest of the inhabitants; but they are exempt from military service. This immunity is the result of Moslem prejudice.

In some parts of Upper Egypt there are villages exclusively inhabited by the Copts, and in every village of moderate size is a Mo'al'lim (a title given to all Copts except those of the poor class or peasants), who keeps the register of the taxes. Most of the Copts in Cairo are employed as secretaries and accountants, or tradesmen; they are chiefly engaged in the government offices; and as merchants, goldsmiths, silversmiths, jewellers, architects, builders, and carpenters, they are generally considered more skilful than the Moslems. In the villages they are employed in agriculture, like the rest of the peasantry. The patriarch or head of the Coptic church, judges petty causes among his people in the metropolis, and the inferior clergy do the same in other places; but an appeal may be made to the cadi. A Moslem aggrieved by a Copt may demand justice either from the patriarch or cadi, but a Copt who seeks redress from a Moslem must apply to the cadi. The Copts are somewhat under the middle size. They are extremely bigoted, and bear a bitter hatred to all other Christians; they are of a sullen temper, extremely avaricious, great dissemblers, ignorant, and faithless. In their habits they scarcely differ from their fellow-countrymen. Their dress, with the exceptions already noticed, is similar. The women veil their faces, according to the custom of the country. The Copts frequently indulge in excessive drinking; but in their meals, the mode of eating, the manner in which they pass their hours of leisure, which is chiefly in smoking their pipes and drinking coffee, they resemble the other inhabitants of the country. The women, however, though closely veiled when out of doors, like the Turkish women, eat at the same table with their husbands and family, unveiled, even in the presence of strangers; and the priest has unrestricted access to them for the purposes of confession.

The Coptic hierarchy consists of a patriarch, a metropolitan of the Abyssinians, bishops, arch-priests, priests, deacons, and monks. The patriarch is styled "Patriarch of Alexandria," but generally resides in Cairo. He is usually chosen by lot, and always from several monks of the convent of St. Anthony, in the Eastern Desert, who are nominated by the superior. He continues to observe the monastic regulations, one of which is to remain unmarried. The metropolitan of Abyssinia, who always resides within his diocese, is appointed by the patriarch, and retains his office for life. The number of bishops is twelve, who are generally chosen from the monastic order. The arch-priests are numerous, and selected from among the priests. The priests are required to be of the age of thirty-three years at the least, and are not permitted to marry, though they may have married before taking the priesthood; but if the wife dies they cannot marry again; and the widow of a priest is not allowed to marry a second husband. The priests are supported only by alms and by what they obtain by their own industry. A deacon must be either a person unmarried, or have been only once married to a virgin bride. By taking a second wife he loses his office. The monks undergo a severe novitiate, and take the vow of celibacy. The churches contain ill-executed and gaudy pictures of various saints, but no images are admitted. The number of Coptic churches and convents is said to amount to 146, but the former are few in comparison with the latter. The form of service is not characterised by much solemnity, and the conduct of the priests is often somewhat indecorous. The marriage ceremony is performed either by a priest, or without his assistance by mutual consent before witnesses; and divorces are as easily to be obtained by either party as with the Mussulmans. Baptism is practised under a belief that if the ceremony be omitted the child will be blind in the next world. The children are generally circumcised; but in Cairo the custom is less strictly observed than in other parts of the country. Confession is required of all members of the Coptic church, and is indispensable before receiving the Lord's supper. Wednesday and Friday are observed as fast-days, except during the fifty days immediately following the Great Fast. The seven great festivals are as follow:—the Nativity of Christ, Baptism, the Annunciation, Palm Sunday, Easter, the Ascension, and Whit-Sunday. The Copts are not allowed by their church to intermarry with persons of any other sect.

(*An Account of the Manners and Customs of the Modern Egyptians, written in Egypt during the years* 1833, 1834, and 1835, by Edward William Lane; *Reise in den Orient*, by Konstantin Tischendorf, Leipzig, 1846.)

COPTIC LANGUAGE, the language spoken and written by the inhabitants of Egypt since the introduction of the Christian religion into that country; and distinguished from the more ancient Egyptian language, which was in use under the Pharaohs and the Ptolemies. What was the relation of the ancient to the more recent language of Egypt, we are unable to determine, as our information respecting the former is very imperfect. Egypt lost much of its consequence when it became a Roman province; and when Alexandria ceased to be a royal residence, arts and literature would naturally fall into decay. Another cause which proved fatal to Egyptian literature was the early introduction of Christianity into Egypt. This event which contributed to extend the study of Greek literature and the use of the Greek language, at the same time deprived the ancient literature of the country, as chiefly connected with the old religion, of the better part of its interest. Notwithstanding these unfavourable circumstances, the language of the country continued in ordinary use, particularly in the interior provinces. Many hermits in the desert of Thebaïs, and many bishops of Upper and Lower Egypt, knew no other language; and the Egyptian, or as it is more appropriately called during these later times, the Coptic language survived for seven or eight centuries after the conquest of Egypt by the Arabs, but it gradually gave way to the Arabic, which is now the language generally in use throughout Egypt.

The literature extant in the Coptic language is by no means rich. The only part of any intrinsic value seems to be the Coptic translations of the Bible, probably made towards the close of the 3rd and in the beginning of the 4th century, and following, as far as the Old Testament is concerned, the Septuagint version, the readings of which, as well as those of the Alexandrine text of the New Testament, they may serve to determine. Of the prophets Isaiah, Jeremiah, Ezekiel, and Daniel, Dr. Henry Tattam published an edition, with a parallel Latin version, in 1852. Besides these, there exist Coptic translations of sermons from the Greek fathers, fragments of the decrees of councils, likewise generally translated from the Greek, liturgies, acts of martyrs, original mystic treatises on ethics, with numerous examples from the lives of pious hermits, and translations from the Greek of some apocryphal books of the New Testament.

Such as we find it, the Coptic language exhibits evident traces of the fate of the country in which it was spoken. Under the Ptolemies, and afterwards under the Romans, new forms of government and administration were introduced into Egypt; and the inhabitants necessarily borrowed from their conquerors the names of public offices and other terms relating to political matters. The Coptic language received a further supply of foreign words in consequence of the introduction of Christianity. A great number of Greek words were retained in the Coptic versions from an apprehension, as it seems, of profaning the Christian doctrine by venturing to translate expressions deemed peculiarly holy in the Greek original text. It has been remarked, that the proportion of Greek expressions is not the same in all Coptic writings; and that only few occur, for which equivalents might not be found among the genuine Coptic words.

It is well known that the ancient Egyptians, besides the hieroglyphics, possessed an alphabet or syllabic system of writing of their own. In the modern Coptic we find the Greek alphabet employed, with eight new letters added to it, to express certain articulations peculiar to the Copts. It is uncertain at what period the Greek alphabet came into use.

Athanasius, bishop of Kous, in an Arabic treatise on the grammar of the Coptic language, a manuscript of which is preserved in the Royal Library at Paris, informs us that there were three dialects of Coptic; namely, the dialect of Misr or Upper Egypt, commonly called the Sahidic; the Bahiric, so denominated from Bahirah, or Lower Egypt, and usually called the Memphitic; and the Bashmuric, spoken in the district of Bashmur, in the Delta. In the Bahiric, or Memphitic dialect, as well as in the Sahidic, we possess manuscripts of nearly the whole of the Bible and of the services of the Coptic church, besides some other less important works; but in the Bashmuric dialect only a few fragments have hitherto been discovered and published. The character common to all these dialects is that of a language which, having lost its original power of expressing by grammatical inflection the relations of notions in sentences, has, like most other modern languages, resorted to particles and auxiliary words to supply that deficiency. The precision with which these auxiliary words are employed, and the extent to which they can be combined in forming derivative words, are remarkable, and may well be compared with the use of letters and other symbols in an algebraical formula. The plural of nouns is distinguished from the singular by a monosyllabic prefix; the genders of substantives are seldom marked by a peculiar termination, but are determined either by the article, or by the addition of a word implying "male" and "female." There are no terminations of case; and all changes of declension must be expressed by means of particles. There is a definite and an indefinite article. The definite article has in the singular distinct forms for the masculine and feminine genders, but does not distinguish the gender in the plural; the indefinite article admits of a distinction of number only. The degrees of comparison are expressed by subjoining auxiliary words to the adjective, which is unalterable. The personal pronouns are almost the only part of speech that has preserved some traces of inflection: besides these, the Coptic has separate forms for the possessive, demonstrative, the relative, and the interrogative pronouns, and has pronominal suffixes and insertions (infixes) which are applied to nominal and verbal inflexions. Ordinal numbers are formed by prefixing various auxiliary words to the cardinal numbers. The verb has only an active voice, and the passive must be expressed by circumlocution, usually by the third person of the plural (as in Latin, *ferunt = fertur*, or in English, *they say = it is said.*) The imperative generally exhibits the root of the verb in its pure state. The conjugation of verbs is accomplished by adding pronominal prefixes to the root, which vary to a certain extent in the different tenses; if a verb in the third person singular is preceded by a relative pronoun, its pronominal prefix is usually dropped; there are no participles in the strict sense of that term. The number of prepositions in the Coptic language is considerable.

Of the three dialects, the Memphitic, Sahidic, and Bashmuric, the first appears to be the most polished. The Sahidic has admitted a greater number of Greek expressions. Words which in Memphitic end in *i*, have in Sahidic *e* for their termination. The Sahidic substitutes the sound *h* for the Memphitic *kh*, and the tenues *π*, *κ*, *τ*, for the aspiratæ *θ*, *χ*, *ϑ*, also sometimes *oo* for *ω*, and *sh* for *j*. The Bashmuric agrees with the Sahidic in preferring the tenues *π*, *κ*, *τ*, to the corresponding aspiratæ, and *h* to *kh*; moreover, it substitutes the vowel *a* for the Memphitic *o*, and *e* for the Memphitic *a*, *ei* often for *i*, *au* for *ov*, *b* for *f*, and particularly *l* for *r*.

(Henry Tattam, *A Compendious Grammar of the Egyptian Language*, London, 1830, 8vo, and *Lexicon Ægyptiaco-Latinum*, Oxford, 1835, 8vo; Am. Peyron, *Lexicon Linguæ Copticæ*, Turin, 1835, 4to; Quatremère, *Récherches Critiques et Historiques sur la Langue et la Littérature de l'Egypte*, Paris, 1808, 8vo; Dr. G. Parthey, *Vocabularium Coptico-Latinum et Latino-Copticum e Peyroni et Tattami Lexicis*, Berlin, 1844.)

COPULA, a name given in logic to the affirmation *is*, or the denial *is not*, by which the subject and predicate of a proposition are connected, as in "Man *is* mortal," "Every man *is not* perfect." In the usual system of logic no other copula is permitted: thus, "Man *has* reason," would be expressed as "Man *is* a being having reason." [Proposition; Relation.]

COPYHOLD, a term in English law applied to lands held by what is called tenure by copy of court roll, the nature of which is thus described by Littleton (§ 73, 4, 5), "Tenant by copy of court roll is as if a man be seised of a manor, within which manor there is a custom which hath been used time out of mind of man, that certain tenants within the same manor have used to have lands and tenements to hold to them and their heirs in fee-simple or fee-tail, or for term of life, at the will of the lord, according to the custom of the same manor. And such a tenant may not alien his land by deed, for then the lord may enter as into a thing forfeited unto him. But if he will alien his land to another, it behoveth him after the custom to surrender the tenements in court into the hands of the lord, to the use of him that shall have the estate. And these tenants are called tenants by copy of court roll, because they have no other evidence concerning their tenements, but only the copies of court rolls." From this it appears that the title to copyhold lands is not only modified but altogether constituted by custom; subject to the estates in them which the custom confers they are held by the lord under the common law as part of the demesnes of his manor. For these customary estates were in their origin mere tenancies at will, though by long indulgence they have in many instances acquired the character of a permanent inheritance descendible (except where otherwise modified by custom) according to the rules of the common law; and as tenancies at will they continue to be considered, in all questions relating to the *legal*, as distinguished from the customary property in the land.

The origin of copyholds is involved in great obscurity. The opinion generally adopted among our lawyers and antiquarians, and supported by the authority of Littleton, Coke, Sir Martin Wright, and Mr. Justice Blackstone, is, that copyholders have gradually arisen out of the villeins or tenants in villeinage who composed the mass of the agricultural population of England for some centuries after the Norman conquest, through the commutation of base services into specific rents either in money or money's-worth. ('Co. Litt.,' 58a—61a; Blackstone's 'Com.,' ii., p. 89, Dr. Kerr's ed.; Wright, 'On Tenures,' 3rd edit., p. 215; Hallam's 'Middle Ages,' vol. iii., p. 254.) [Villeinage.]

Although the revolution in the condition of these classes of persons was accomplished gradually, it seems in the middle of the 13th century to have begun to assume a more decided character. There are proofs of as early a date as the reign of Henry III. of a limitation of the services of villeins to certain specified acts which were recorded in the lord's book. The descendants of persons so privileged began to claim a customary right to be entered on the court roll on the same terms as their predecessors, and, in process of time, prevailed so far as to obtain a copy of the roll for their security. It is said in the year-book of the 42nd of Edw. III. to be "admitted for clear law that if the customary tenant or copyholder did not perform his services, the lord might seize his land as forfeited;" which seems to imply a permanent interest in the copyholder, so long as he performed the services. This view of the law is confirmed by Britton in a passage cited by Lord Coke ('Co. Litt.,' 61a), and was adopted by the judges in Edward IV.'s time, who held that a copyholder might maintain an action of trespass against the lord for dispossession.

The two great essentials of copyhold tenure, according to Blackstone, are: 1. That the lands be parcel of and situate within that manor under which they are held; and, 2. That they have been demised or demisable by copy of court roll immemorially. "For immemorial custom," says that author, ii., p. 94 (Dr. Kerr's Ed.), "is the life of all tenures by copy; so that no new copyhold can, strictly speaking, be granted at this day."

The burdens to which a copyhold tenure is liable, in common with free tenures, are fealty, services, reliefs, and escheats; besides which it has certain liabilities peculiar to itself in the shape of heriots and fines. A heriot is the render of the best beast or other chattel (as the custom may be) to the lord on the death of a tenant.

Of fines, some are due on the death of a tenant, and others on the alienation of the land; they are sometimes fixed by the custom, sometimes arbitrary; but in the latter case it is an established rule of law that the lord cannot demand by way of fine upon the descent or alienation of the land more than the amount of two years' improved value of the property, after deduction of the quit-rents to which it is liable. The ordinary mode of alienating a copyhold estate in fee-simple is by *surrender and admittance*, which is effected in the following manner:—The copyholder appears in court, and professes to surrender or deliver up his land to the lord (either in person or, which is more usual, as represented by his steward), expressing the surrender to be to the use of A, and his heirs; and thereupon A is *admitted* tenant of the land to hold it to him and his heirs at the will of the lord according to the custom of the manor. He then pays a fine, and also (if required) does fealty. All these circumstances, or at least the surrender and admittance, are entered on the court rolls; and the new tenant, paying his fees to the steward, receives a copy of this fundamental document of his title. Surrenders are made in various forms, as by the delivery of a rod, glove, or other symbol, to the steward or other person taking the surrender. Surrenders may also be made to the lord in person out of court; to the steward; and by special custom to the lord's bailiff; to two or three copyholders, or into the hands of a tenant in the presence of other persons. When a surrender is taken out of court, it may be, and formerly must have been, presented by the homage or jury of copyholders at the next general court, except where a special custom authorised a presentment at some other court; but by a recent statute, 4 & 5 Vict., c. 35, s. 90, presentment is now no longer essential. Admittances also may be made out of court, and even out of the manor.

The words in the admittance, "to hold at the will of the lord," are characteristic of those customary estates to which the term copyhold is in ordinary legal language exclusively appropriated, in contradistinction to what are sometimes called "customary freeholds" (which estates are very common in the north of England), and ancient demesne lands. These are all included under the term copyhold in the Statute 12 Car. II. c. 24, which abolished all the old tenures in England except common soccage, copyhold, and some other specified tenures. Though customary freeholds and ancient demesne lands for the most part pass by surrender and admittance, the admittance is expressed to be "to hold according to the custom of the manor."

The Statutes of Wills (32 Henry VIII. c. 1, and 34 & 35 Henry VIII. c. 5) do not include copyholds, and therefore formerly it was necessary in order to enable a person to dispose of copyholds by will that he should first have surrendered them "to the use of his will," as it was called. This ceremony was rendered unnecessary by the Statute 55 Geo. III. c. 192, which, however, does not extend to customary freeholds; but the Wills Act (1 Vict. c. 26) extends the power of disposition by will, without surrender to the use of the will and even before admittance, to customary freeholds and all customary or copyhold estates whatsoever. A devise of copyholds by will might formerly have been made without observing the formalities prescribed by the Statute of Frauds (29 Car. II. c. 3), the terms of that statute not extending to copyholds; but the requirements of the Wills Act (1 Vict. c. 26) must now be complied with. The Statute of Entails (13 Ed. I.), commonly called the Statute of Westminster the 2d, does not extend to copyholds; but in most manors a custom of entailing copyholds has prevailed. These entails might formerly be barred by a proceeding in the Lord's Court, analogous to a common recovery, or, in the absence of a custom authorising such a proceeding, by a mere surrender. And now by Statute (3 & 4 Will. IV. c. 74, § 50–54 inclusive) entails of copyholds may be barred by assurances made in pursuance of the provisions of that Act. It is a general rule that no statute relating to lands or tenements in which those of a customary tenure are not expressly mentioned, shall be applied to customary estates, if such application would be derogatory to the customary rights of the lord or tenant. Hence neither the provision in the Stat. of Westm. the 2d (13 Ed. I. c. 18), rendering debtors' lands liable to process of execution by writ of elegit, nor the Statute of Uses (27 Henry VIII. c. 10), nor the Statute of Partition (31 Henry VIII. c. 1, and 32 Henry VIII. c. 32), nor the Statute enabling persons having certain limited interests in lands to grant valid leases (32 Henry VIII. c. 28), nor any of the local Registry Acts, were applicable to copyholds.

Until a recent period copyholds could not be seized upon an outlawry, nor were they assets for payment of specialty debts at law, nor were they even liable for debts due to the crown, although they were always subject to sequestration under the decree of a court of equity. But copyhold lands belonging to traders were subjected to the operation of the bankrupt laws (v. stat. 6 Geo. IV. c. 16, sec. 68 and 69); and by Stat. 3 & 4 Will. IV. c. 104, copyhold lands of all persons whatever which have not been devised for payment of debts, are rendered assets to be administered in a court of equity for the payment of specialty and simple contract debts. Copyholds are not liable (except by special custom) to the incidents of curtesy or dower. The latter, where authorised by the custom, is called the widow's "free bench." These estates being considered continuations of that of the deceased tenant, are perfected without admittance. A purchaser or devisee of copyholds has an incomplete title until admittance; but the customary heir is so far legal owner of the land *before admittance* that he can surrender or devise it, or maintain an action of trespass or ejectment in respect of it. The lord may by a temporary seizure of the land compel an heir or devisee to come in and be admitted; and he is himself compellable by a mandamus of the Court of King's Bench to admit any tenant, whether claiming by descent or otherwise.

By the general custom of all manors, every copyholder may make a lease for any term of years, if he can obtain a licence from the lord, and even without such licence he may demise for one year, and in some manors for a longer term, and the interest thus created is not of a customary nature, but a legal estate for years, of the same kind as if it had been created out of a freehold interest. But every demise without licence for a longer period than the custom warrants, and in general, every alienation contrary to the nature of customary tenure, as a feoffment with livery of seisin, is followed by a forfeiture to the lord. A copyhold estate may also be forfeited by waste; as by cutting down timber, or opening mines, when such acts are not warranted by the custom. In the absence of such special custom, the general rule seems to be that the right of property both in trees and mines, belongs to the lord, while only a possessory interest is vested in the tenant; but neither can the lord without the consent of the tenant, nor the tenant without the licence of the lord, cut down trees, or open and work new mines. In like manner forfeiture may be incurred by an inclosure or other alteration of the boundaries of an estate, refusal to attend the customary courts, or to perform the services, or to pay the rent or fine incident to the tenure. The 9th section of the 1st Wm. IV. c. 65, protects infants, lunatics, and married women from the last mentioned cause of forfeiture. In case of felony or treason being committed by a copyholder, the lord has the absolute benefit of the forfeiture, unless it has been expressly provided otherwise by Act of Parliament. In all cases of forfeiture the lord may recover the forfeited estate by ejectment, without prejudice to the rights of the copyholders (if any there be) in reversion or remainder. He may waive the forfeiture by a subsequent act of recognition of the tenure. If he does not take advantage of the forfeiture for twenty years, his right to do so is barred by the Act for the Limitation of Actions, 3 & 4 Wm. IV. And if he neglect to take advantage of the forfeiture in his life-time, his heir cannot avail himself of it.

The lord may also become entitled to a customary tenement by escheat for want of heirs. Formerly where a copyhold was surrendered to a mortgagee and his heirs, and no condition was expressed in the surrender, and the mortgagee died intestate and without an heir, the lord was entitled to enter for escheat. To remedy this, the 13 & 14 Vict. c. 60, repealing 4 & 5 Wm. IV. c. 23, which contained a provision with a similar object, enacts that where a trustee or mortgagee of lands of any tenure whatsoever, dies without an heir, the Court of Chancery may make an order vesting such land in such persons, and for such estates as the court shall direct.

If the lord (having acquired a copyhold tenement by forfeiture, escheat, or surrender to his own use) afterwards grant it away by an assurance unauthorised by the custom, the customary tenure is for ever destroyed. And if he makes a legal conveyance in fee-simple of a copyhold tenement to the tenant, the tenement is said to be enfranchised, that is, converted into freehold.

Copyholders were till very lately incapable of serving on juries, or voting at county elections of members of parliament; but the former disability was removed by 6 Geo. IV. c. 50, s. 1, and the latter by the 2 & 3 Wm. IV. c. 45, s. 19. As to the qualification for killing game under 22 & 23 Car. II. c. 25, s. 3, there seems to be no distinction between freeholders and copyholders.

There are no lands of a copyhold tenure in Ireland.

The statute of wills, 1 Vict. c. 26, which has been before alluded to, contains also the following provisions as to the testamentary disposition of copyholds, which require notice here. The 4th section provides that where any real estate of the nature of customary freehold, or tenant right, or customary or copyhold, might by the custom of the manor of which the same is holden, have been surrendered to the use of a will, and the testator shall not have surrendered the same, no person claiming to be entitled under his will shall be entitled to be admitted, except upon payment of all such stamp duties, fees, and sums of money as would have been due in respect of the surrender of such estate, or the presentment, registering, and enrolment of such surrender to the use of his will. And also, that where the testator, being entitled to admission to any real estate, and upon such admission to surrender the same to the use of his will, shall not have been admitted thereto, no person claiming to be entitled to such real estate in consequence of such will shall be entitled to admission, except on payment of all such stamp duties, fees, fine, and sums of money as would have been due in respect of the admittance of the testator to such real estate, the surrender to the use of his will, the presentment, registering, or enrolment of such surrender; all such stamp-duties, fees, fine, or sums of money to be paid in addition to the stamp duties, fees, fine, or sums of money due on the admittance of the person so claiming to be entitled to such real estate.

By the 5th section, when any real estate of the nature of customary freehold, or tenant right, or customary, or copyhold, is disposed of by will, the lord of the manor, or reputed manor, of which such real estate is holden, or his steward, or the deputy of such steward, is to cause the will by which such disposition is made, or an extract thereof, to be entered on the Court Rolls; and when any trusts are declared by the will, it is not to be necessary to enter the declaration of such trusts, but it is to be sufficient to state in the entry on the Court Rolls that such real estate is subject to the trusts declared by the will; and when such real estate could not have been disposed of by will, except by virtue of the act, the same fine, heriot dues, duties, and services are to be paid and rendered by the devisee as would have been due from the customary heir in case of the descent of such real estate. And the lord is, as against the devisee, to have the same remedy for recovering and enforcing such fine, heriot dues, duties, and services as he is entitled to against the customary heir in case of a descent.

By the 6th section, if no disposition by will be made of any estate *pur auter vie* of a freehold nature, the same is to be chargeable in the hands of the heir, if it come to him by reason of special occupancy, as assets by descent, as in the case of freehold land in fee simple; and in case there be no special occupant of any estate *pur auter vie*, whether freehold or customary freehold, tenant right, customary or copyhold, or of any other tenure, and whether a corporeal or incorporeal hereditament, it is to go to the executor or administrator of the party that had the estate by virtue of the grant; and if the estate come to the executor or administrator, either by reason of a special occupancy or by virtue of the act, it is to be assets in his hands, and to go and be applied and distributed in the same manner as the personal estate of the testator or intestate. By the 26th section a general devise of the testator's lands is to include copyholds, unless a contrary intention appear by the will; which is an alteration of the old rule whereby copyholds did not pass under a general devise of "lands, tenements, and hereditaments," or other general words descriptive of real estate, unless the copyholds had been surrendered to the use of the will, or the testator had no freehold lands upon which it could operate. And besides the above-mentioned changes relating peculiarly to copyholds, all the other enactments of the act, including that which prescribes the formalities to be observed in making a will, are applicable to estates of copyhold or customary tenure.

By the 11th section of the 1 & 2 Vict. c. 110, copyholds are made subject to execution by judgment creditors in the same manner as freeholds.

Still greater changes in the nature of estates of copyhold and customary tenure are gradually taking place under the provisions of the stats. 4 & 5 Vict. c. 35; 6 & 7 Vict. c. 23; 7 & 8 Vict. c. 55; 15 & 16 Vict. c. 51: and 21 & 22 Vict. c. 94.

The principal objects of these Acts are, 1. The commutation of certain manorial rights in respect of lands of copyhold and customary tenure; 2. The facilitating the enfranchisement of such lands; and 3. The improvement of such tenure. The first of these Acts provided a cumbrous machinery for general commutations which was not found very effective, and it merely enabled commutations and enfranchisements to be made, where all parties were agreed, but without empowering either party, whether lord or tenant, to compel the other to enfranchise or commute. Under its enactments, however, a good many enfranchisements took place in the case of manors of which ecclesiastical bodies were the lords, under the direction of the ecclesiastical commissioners. The Act 15 & 16 Vict. c. 51 (1852), first introduced the important principle of enabling one party, whether lord or tenant, to compel the concurrence of the other in enfranchisement, and this Act has been found very efficacious. Its first section enacts, that "at any time after the next admittance to any lands which shall take place on or after the first day of July, 1853, in consequence of any surrender, bargain and sale, or assurance thereof (except upon or under a mortgage in cases where the mortgagee is not in possession), or in consequence of any descent, gift, or demise, and whether such surrender, bargain and sale, or assurance, shall have been made, passed, or executed, or such descent shall happen, or such gift or demise shall take effect before or after that day, it shall be lawful for the tenant so admitted, or for the lord, to require and compel enfranchisement in manner hereinafter mentioned of the lands to which there shall have been such admittance as aforesaid." The mode of effecting enfranchisement directed by this Act has been since altered by 21 & 22 Vict. c. 94 (1858), of which the eighth section enacts, that "when any lord or tenant shall, under the provisions of the Copyhold Act, 1852, or of this Act, require the enfranchisement of any land held of a manor, he shall give notice in writing (the lord or his steward to the tenant, or the tenant to the lord or his steward) of his desire that such land shall be enfranchised, and the consideration to be paid to the lord for such enfranchisement, and also the sum to be paid to the lord in respect of a heriot due for a customary freehold, shall, unless the parties agree about the same, be ascertained under the directions of the copyhold commissioners, and upon a valuation made in manner following: (that is to say), when the manorial rights to be compensated shall consist only of heriots, rents, and licences, at fixed rates, to demise or fell timber, or any of these, or when the land to be enfranchised shall not be rated to the poors' rate at a greater amount than the net annual value of 20*l.*, then the valuation shall be made by a valuer to be nominated by the justices at a petty session holden for the division or place in which the manor or the chief part thereof is situate: provided that no justice, being lord, either in whole or in part, of such manor, shall take any part in nominating such valuer; subject, however, to these provisoes: first, that if the parties agree to recommend to the commissioners any person to be the valuer, such person shall be nominated by the commissioners; and second, that either party may, upon paying the charges of his own valuer, have the valuation made as next hereinafter provided. But when the manorial rights to be compensated do not consist only of rents and heriots and such licences as aforesaid, or when the land to be enfranchised is rated to the poors'-rate at a greater amount than the not annual value of 20*l.*, or where the valuation to be made is of the sum to be paid to the lord in respect of a heriot due for a customary freehold, then the valuation shall, unless the parties agree to refer it to one valuer, be made by two valuers, one to be appointed by the lord, and the other by the tenant; and such two valuers, before they proceed, shall appoint an umpire, to whom any points in dispute between them shall be referred; and in case the valuer or valuers, or umpire, as the case may be, shall not make a decision and deliver the particulars thereof in writing to the lord or steward and to the tenant, and to the copyhold commissioners, within forty-two days after the appointment of such valuers, or reference of the matter to the umpire, as the case may be, then the commissioners shall fix the consideration to be paid or rendered to the lord; and in any case when, after notice to the lord or steward, or to the tenant so to do, either party shall neglect or refuse, for twenty-eight days, to appoint his valuer, the commissioners shall appoint a valuer for him as soon as may be after the expiration of such twenty-eight days; and in any case where any valuers shall, for the space of fourteen days after the appointment, be unable to agree in the appointment of an umpire, the commissioners shall appoint an umpire." This last-mentioned Act also enables lord or tenant to compel enfranchisement of a copyhold to which the last admittance shall have taken place before the 1st of July, 1853.

The following table, which is taken from the 'Seventeenth Report of the Copyhold Commissioners,' dated December 31, 1858, will show what has been effected under the operation of the enfranchisement Acts. The table distinguishes the manner in which enfranchisement has taken place into clerical, collegiate and lay, and shows the number of distinct operations, whether of enfranchisement or commutation, which have taken place in each during a period of seventeen years from the first commencement of the system:—

Years.	Clerical.	Collegiate.	Lay.	Total.
1841	1	—	—	1
1842	9	—	3	12
1843	15	1	13	29
1844	24	—	15	39
1845	44	—	12	56
1846	49	—	7	56
1847	38	1	13	52
1848	16	1	8	25
1849	19	1	10	30
1850	27	1	9	37
1851	31	2	31	64
1852	31	—	13	44
1853	36	6	16	58
1854	59	11	61	131
1855	42	32	146	220
1856	46	23	162	231
1857	52	21	230	303
1858	32	13	159	204

The rapid increase of enfranchisements under the operation of the compulsory clauses is observable, and ultimately it may be anticipated that copyhold tenure will cease to exist.

COPYING-MACHINES. The great value of a convenient and certain means of copying any piece of writing with perfect accuracy, and with less labour than is involved in the process of transcribing, has led to numerous inventions which may be classed under the general name of copying-machines, some of which are extensively used in mercantile establishments for producing duplicates of letters, invoices, and other MS. papers.

The most simple and obvious mode of effecting this object is by transferring, by means of a rolling or screw-press, a portion of the ink with which a letter is written to the surface of a sheet of blank paper, prepared to receive it by damping. The transfer thus obtained is of course the reverse of the original letter, and, unless it be taken on paper so thin and transparent that it may be read through it, must be read backwards. Watt's copying-press was a contrivance for obtaining transfers of this kind upon thin unsised paper, wetted, and then placed between two woollen cloths, which absorbed all unnecessary moisture. Elegant screw-presses of iron are manufactured for this purpose, of various designs; some having the power applied solely by means of a screw, turned by a transverse bar or lever, or by a cross or wheel-shaped handle; while others have also a contrivance for increasing the pressure beyond what can be conveniently applied by the simple turning of the screw. One of the best and simplest copying-presses is that invented by Mr. Ritchie, of Edinburgh, in which the platten is depressed by a screw, turned by a short transverse handle, until a moderate pressure is given; after which, by the movement of a second lever-handle acting upon an excentric cam, which bears upon a piece of steel attached to the head of the screw, the screw and platten are further depressed through a very small space, but with immense force. Barlow describes a very simple and compact copying-machine invented by the elder Brunel, in which the pressure is given by means of levers. In some cases, letters intended for transferring by the copying-press are written with an ink made for the purpose; or, when common ink is used, it may be thickened by adding a little sugar to it. In some cases the transfers are taken from the pages of a MS. book prepared for the purpose, a sheet of dry oiled paper being placed over the damp sheet to prevent the transmission of the moisture. It is almost needless to observe that transfers may be taken from several written sheets at one operation of the press.

Hebert gives the following description of a simple, and, he says, effectual copying-machine: "Take a roller of beech, or any hard wood, about 18 inches long and 1 inch in diameter, and having cut a longitudinal slit therein nearly the whole length, insert in it and fasten very neatly with glue a slip of strong cloth, about 14 inches wide and 18 inches long; the remaining part of the roller will serve as a handle, and may be cut with several faces to obtain a firmer hold. To use this copying-press, lay the sheet of paper on which the letter is written upon the strip of cloth; on that place the thin copying-paper, and upon these lay a thick baize or horse-hair pad; then roll the whole round the roller, and grasping that part where the cloth is with the left-hand, turn the roller round with the right, gradually increasing the grasp with the left; the pressure becomes very great, and quite sufficient to transfer the letter to the copying-paper."

Holland, in Lardner's 'Cabinet Cyclopædia,' mentions a plan suggested by Dr. Franklin, which, although he styles it ineligible in practice, is worth recording as conveying an idea which might be usefully applied. He proposed to write the original letter with a gummy ink, and then to strew it over with flour-emery, which would be retained by the ink, though it would not adhere to any other part of the surface of the paper. The writing was then to be laid, face downwards, upon a smooth pewter-plate, and subjected to the action of a powerful rolling-press, which, he conceived, would cause the emery to make an impression of the writing upon the surface of the metal, which might be charged with printing ink, and printed from like an engraved plate.

Mechanical contrivances for enabling a person to write with two pens or pencils at once, on different sheets of paper, on the principle of the PANTOGRAPH, have been tried as copying-machines; but they are too complicated for ordinary use. All such machines, and perhaps we might say even the copying-press, are far surpassed in convenience by the *manifold writer*, an apparatus patented in 1806, by Wedgwood. In this apparatus a sheet of paper blackened on both sides with printers' ink, and dried for five or six weeks between sheets of blotting-paper, or covered with some other black composition which will come off when pressed hard, but will not move with a slight degree of pressure or friction, is laid between two sheets of thin writing-paper, and the whole is placed upon a smooth copper or pewter-plate. The letter is then written firmly on the upper sheet of paper with an agate style or point, the pressure of which causes the blackened paper to produce two impressions of the writing, one, which is read through the paper, upon the under side of the sheet directly acted upon by the style, and the other upon the upper side of the lower sheet. More than two impressions of the writing may be obtained by using two or more sheets of blackened paper, interposed between several sheets of thin white paper. This apparatus is conveniently fitted up in a small portfolio, and occupies no more room than an ordinary writing-case.

In a machine registered by Messrs. Mordan, a stamping-press is combined with an ordinary copying-machine. When worked in the customary way, the platten rises with the screw, leaving a space beneath it for the copying process; but by a little adjustment the screw may be raised without the platten, leaving a die and counter-die in proper position for stamping any device on letters, envelopes, or paper.

In 1855 Mr. Terry patented a copying-machine to be combined with the cover of a book. The act of closing the book furnishes the means for copying documents placed between the leaves. Outside each cover is a metallic frame; one of these carries an inclined projecting piece at each end, while the other has two or three links hinged to each end. When the book is to be closed, the links are pressed over the inclined projecting pieces, and may be thus held compressed for any length of time. The pressure is sufficient to effect a transfer of ink as in a copying-press; but great rigidity in the frames is required.

COPYRIGHT, or, as it was formerly termed, copy, has been defined by Lord Mansfield, "to signify an incorporeal right to the sole printing and publishing of somewhat intellectual, communicated by letters." By this "somewhat intellectual" is to be understood something proceeding from the mind of the person by whom, or through whom, such a right is claimable. Yet, although mere republications of the compositions of others are no subject for copyright, it is by no means limited to such productions as contain new or original ideas. Thus translations both from ancient and modern languages, notes and additions to existing works, even compilations and abridgements, are similarly protected. As to these last however it is often a question for courts and juries to decide, whether the compiler or abridger really intended to present the original matter in a more useful or agreeable form, expended his own labour upon it, and so entitled himself to protection, or whether he only sought, under false pretexts, to defraud the author or his assigns of a portion of their lawful profits. This decision depends of necessity on the circumstances of each particular case. Further, a right of copy attaches to the authors of ideas expressed by other symbols as well as letters, to musical composers for example.

The origin of copyright must be sought in the general conviction which has always prevailed of its justice and expediency. "When a man," says Blackstone, "by the exertions of his rational powers has produced an original work, he seems to have clearly a right to dispose of that identical work as he pleases; and any attempt to vary the disposition he has made of it, appears to be an invasion of the right. Now the identity of a literary composition consists entirely in the sentiment and the language. The same conceptions, clothed in the same words, must necessarily be the same composition; and whatever method be taken of exhibiting that composition to the eye or ear of another, by recital, by writing, or by printing in any number of copies, or at any period of time, it is always the identical work of the author which is so exhibited, and no other man, it hath been thought, can have a right to exhibit it, especially for profit, without the author's consent." ('Comm.' Dr. Kerr's ed., vol. ii., p. 414.)

Accordingly it has been supposed that a common-law right of copy existed in England previously to any statute on the subject. As a legal proposition however this cannot be supported by the proper and direct proof of a fair judicial decision before the passing of the first statute relating to it in the reign of Queen Anne; inasmuch as it never appears to have been directly controverted up to that time. But, in the absence of positive authority, it may be fairly inferred, from the old charters of the Stationers' Company, and much more from their registers, whence it appears that some thousands of books, even as early as the times of Elizabeth, passed from one owner to another by descent, sale and conveyance; from acts and ordinances of parliament which necessarily imply a recognition of it by the nature of their provisions respecting printing; and from decrees of the Star-chamber, which, though not binding precedents, are evidence of the opinion of many learned men as to the then state of the law. It is further to be noted, that the non-existence of express decisions on the point is accounted for down to 1640 by the necessity of obtaining a licence prior to the printing of anything, so that authors had no occasion to apply to civil tribunals for protection, as none but themselves and those claiming under them were so licensed, and he who printed a book without this was subject to enormous penalties.

It has hardly been controverted in the various arguments that exist upon this common-law right of copy that literary compositions in their original state, and the incorporeal right of the publication of them, are the private and exclusive property of the author. The question made has been that this property was put an end to by publication; and yet without publication it is useless to the owner, because it is without profit, and property without the power of use or disposal is not property. In that state it is lost to society as a means of improvement, as well as to the author as a means of gain. Publication is therefore the necessary act and only means to render such a property useful to the public and profitable to the owner. If, says Lord Mansfield, the copy which belonged to the author before publication does not belong to him after, where is the common law to be found which says there is such a property before. All the metaphysical subtleties from the nature of the thing may be equally objected to the property before. It is equally detached from the manuscript or any physical existence whatsoever. There is in fact nothing in the act of publication to vary the nature of the right, so that that which is necessary to make a work useful and profitable should be taken as destructive at once of an author's confessed original property against his expressed will. It has accordingly been the almost unanimous opinion of the high authorities who were called on to decide the point, that by the common law of England authors were entitled to copyright, and as there was nothing in statute or custom to determine it, or distinguish this from other species of property, that such right was once perpetual. The arguments for the contrary opinion are collected in the judgment of Mr. Justice Yates in the case of Millan *v.* Taylor, 4th Burrow, p. 2354.

From the above premises arose the question, after the passing of the first statute respecting literary property in 1710, whether by certain of its provisions this perpetual copyright at common law was extinguished for the future. After some less important decisions in the negative on motion in the Court of Chancery and elsewhere, the question was solemnly argued before the Court of King's Bench, during the term, when Lord Mansfield presided, in 1769. The result was a decision in favour of the common-law right as unaltered by the statute, with the disapproval however of Mr. Justice Yates. Subsequently, in 1774, the same point was brought under the consideration of the House of Lords, and the decision of the court below reversed by a majority of six judges in eleven, as Lord Mansfield, who adhered to the opinion of the minority, declined to interfere; it being very unusual, from motives of delicacy, for a peer to support his own judgment on appeal to the House of Lords. It is somewhat remarkable, that although this could be hardly termed a decision, as the judges were in point of fact divided equally, it has since been held so important as a precedent and sustained in so many subsequent cases, that it must now be considered as settled law that perpetual copyright is put an end to by the statutes. And in a recent case, Jeffreys *v.* Boosey (4 Ho. of Lords ca. 815), the House of Lords has even decided that at common law no copyright exists.

The two universities were not slow to protect themselves from the consequences of this decree in the case of Donaldsons and Beckett, and obtained from Parliament, in 1775, the following year, an Act for enabling the two universities in England, the four universities in Scotland, and the several colleges of Eton, Westminster, and Winchester, to hold in perpetuity their copyright in books given or bequeathed to the said universities and colleges for the advancement of useful learning and other purposes of education. This protection, sanctioned by penalty and forfeiture, so long as such books are printed at the presses of the universities and colleges respectively, is still enjoyed, unaffected by the general statutes on the subject; and a similar protection is extended to the university of Dublin by 41 Geo. III. c. 107.

The chief provisions of the 8 Anne, c. 19, entitled 'An Act for the encouragement of learning, by vesting the copies of printed books in the authors or purchasers of such copies during the times therein mentioned,' as regards the effecting of that purpose, were, that the authors of books already printed, and those claiming under the author, should have the sole right and liberty of printing them for a term of 21 years and no longer; and that the authors of books to be printed, and their assigns, should have the same right for 14 years and no longer. And the last clause of the Statute directed that after the expiration of these 14 years the same right should return to the authors, if living, for another 14 years. The persons infringing these provisions were to be punished by forfeiture of the pirated book to the proprietor, and a penalty of one penny for each sheet, one-half to go to the crown and the other half to the informer, provided always the title to the copy of the book had been duly entered with the Stationers' Company.

The 41 Geo. III. c. 107, which extended the same law to Ireland, gave a further protection to authors and their assigns by action for damages and double costs, and raised the penalty per sheet to three pence, to be divided in the same way.

The 54 Geo. III. c. 156, enacted, that the author of any book, and his assigns, should have the sole liberty of printing and reprinting such book for the full term of 28 years from the day of publication, and, if the author should be living at the end of that period, for the residue of his natural life.

But the Act 5 & 6 Vict. c. 45 (Lord Mahon's Act), entitled 'An Act to amend the law of copyright,' and having for its preamble, "Whereas it is expedient to amend the law relating to copyright, and to afford greater encouragement to the production of literary works of lasting benefit to the world," is the Act which now regulates literary property. It repeals the 8 Anne, c. 19; 41 Geo. III. c. 107; 54 Geo. III. c. 156; and enacts that in every book published in the life-time of the author, after the passing of the Act (1st of July, 1842), the author and his assigns shall have copyright for the term of the author's life, and for seven years after his death, or if these seven years expire before the end of forty-two years from the time of publication, then for such period of forty-two years; while for books previously published, in which copyright still subsisted at the time of the passing of the Act, the copyright should be continued for the full term provided in the cases of books thereafter published, except in cases where the copyright should belong wholly or in part to a person other than the author, "who shall have acquired it for other consideration than that of natural love and affection." In these excepted cases however the author, or his personal representative, and the proprietor or proprietors of copyright may agree, before the expiration of the subsisting term of copyright, to accept the benefits of the Act: and on a minute of such agreement being entered in a book of registry directed to be kept at Stationers' Hall, the copyright will be continued, as in other cases, for the author's life and seven years after his death, or for forty-two years from the time of publication, and will be the property of the person or persons specified in the minute. The copyright of a book published after the author's death is to endure for forty-two years from the time of publication, and to belong to the proprietor of the manuscript from which it is first published, and his assigns. With regard to encyclopædias, reviews, magazines, periodical works, or works published in a series of books or parts, or any book in which the publisher or projector shall have employed persons to write, on the terms that the copyright shall belong to himself, the copyright shall be in the publisher or projector, after he has paid for it, in the same manner and for the same term as is given to authors of books, except only in the case of essays, articles, or portions forming part of, and first published in, reviews, magazines, or other periodical works of a like nature, the right of publishing which separately shall revert to the authors at the end of twenty-eight years after publication, for the remainder of the term given by this Act; and during these twenty-eight years the publisher or projector shall not have the right to publish any such essay, article, or portion separately, without the consent of the author or his assigns.

The Act provides, at the same time, against the suppression of books of importance to the public, by empowering the judicial committee of the Privy Council, on complaint made to them that the proprietor of the copyright in any book after the death of its author, refuses to republish or allow the republication of the same, to license the complainant to publish the book, in such manner and subject to such conditions as the Privy Council may think fit.

The remedies provided by this Act for infringement of copyright are, an action for damages (in which the defendant is required, on pleading, to give notice to the plaintiff of the objections to the plaintiff's title on which he means to rely), and a power given to the officers of customs and excise to seize and destroy all foreign reprints of books in which copyright exists, with a penalty on the importer (if he be not the proprietor of the copyright) of 10*l.*, and double the value of every copy of any book imported, on conviction before two justices of the peace; 5*l.* of the penalty to go to the officer of customs or excise who shall procure the conviction, and the remainder to the proprietor of the copyright.

The Act provides that a book of registry be kept at Stationers' Hall, where entries may be made of proprietorships of copyright, assignments thereof, licences of the judicial committee, and agreements as to copyrights subsisting at the time of the passing of the Act, on payment in each case of a fee of 5*s.* The entry of proprietorship of copyright in this book does not affect copyright; but no action can be brought for infringement of copyright, nor any other legal proceedings taken, unless the proprietorship of copyright has been entered.

The entry of an assignment in the registry book is to all intents and purposes an effectual assignment. Certified and stamped copies of entries in the registry book, are to be evidence in all courts of justice, and are to be taken as *primâ facie* proof of copyright. The making of a false entry in the registry book, or the production in evidence of any paper falsely purporting to be the copy of an entry therein, is made a misdemeanor. Persons thinking themselves aggrieved by any entry in the registry book, may apply to a court of law in term time, or a judge in vacation, for an order to vary or expunge such entry; and such court or judge may make an order for varying, expunging, or confirming such entry, with or without costs.

With respect to dramatic literary property and the 3 Will. IV. c. 15, which gave dramatic authors certain privileges and remedies for their infringement, the 5 & 6 Vict. c. 45, has extended the term of the sole liberty of representing dramatic pieces to the period provided by that Act for the copyright of books, and gives the same protection to the authors of musical pieces and their assigns. The remedies provided by the 3 Will. IV. c. 15, in the case of dramatic pieces are confirmed by the 5 & 6 Vict. c. 45, and extended to musical pieces. The 5 & 6 Vict. c. 45, also enacts that no assignment of the copyright of any book consisting of a dramatic piece or musical composition shall convey the right of representing or performing such dramatic piece or musical composition, unless an entry, expressing the intention that such right shall pass by the assignment, be made in the registry book at Stationers' Hall.

The protection given to authors by the Statute of Copyright is coupled with the condition of presenting five copies of every book to certain public libraries. A copy of every work, and of every second or subsequent edition which contains any additions or alterations, bound, sewed, or stitched together, and on the best paper on which the same shall be printed, is to be delivered at the British Museum within one month after its first publication, if it is published within the bills of mortality, or within three months if published in any other part of the United Kingdom, or within twelve months if published in any other part of the British dominions; and a copy of every work, or second or subsequent edition, containing additions and alterations, on the paper of which the largest number of copies shall be printed for sale, in the like condition as the copies prepared for sale by the publisher, is to be delivered, if demanded, within twelve months after publication, within one month after demand made, at Stationers' Hall, for the Bodleian Library at Oxford, the Public Library at Cambridge, the Library of the Faculty of Advocates at Edinburgh, and the Library of Trinity College, Dublin, under penalty of forfeiting the value of the copy of each book or edition not delivered, and a sum not exceeding 5*l.*, to be recovered by the Librarian, or other officer properly authorised, of the library to which the book should have been delivered, on conviction before two justices of the peace for the county or place where the publisher resides, or by action of debt in any Court of Record in the United Kingdom. Formerly, under the 54 Geo. III. c. 156, an author was obliged to give eleven copies of his work to public libraries.

The strict powers given by the 5 & 6 Vict. c. 45, have been vigorously exercised by the Custom-house authorities, and found very effectual to prevent the importation into this country of the French, Belgian, German, and American reprints of popular English works; but English authors still suffer by the circulation of these reprints abroad; and a practice so destructive of the fair profits of mental labour can only be effectually redressed by prevailing on foreign countries to extend the benefits of their own laws against literary piracy to aliens as well as native authors. Two Statutes have been passed in the present reign to enable her Majesty to extend to foreigners the benefits of our laws of copyright. The first of these, 1 & 2 Vict. c. 59, was repealed by 7 Vict. c. 12, the Statute which is now in force, and which was substituted in consequence of the alterations in our law of copyright. This Act, entitled "An Act to amend the law relating to International Copyright," empowers her Majesty by order in council to enable authors of works first published in foreign countries to have copyright in the British dominions for books, prints, articles of sculpture, and the sole liberty of representing dramatic and musical pieces, for periods not exceeding those allowed by the various copyright Acts for the respective classes of works when first published in this country, on conditions of registration and delivering of one copy at Stationers' Hall; but no such order in council is to have any effect unless it is stated therein, as ground for issuing the same, that reciprocal protection for British authors has been secured in the foreign country to which the order in council refers. Under this Act a convention for the mutual protection of copyrights has been entered into with France, and its stipulations have been confirmed by the Act 15 & 16 Vict. c. 12. Similar agreements have likewise been entered into with the free town of Hamburg (1853), with Belgium (1854), and with Prussia (1855).

There are certain works exempted from the benefit of the law of copyright from the nature of their contents: such are, all publications injurious to public morality, inimical to Christianity, or stimulating, either as libellous or seditious, to a breach of the peace. This must however be understood of their general tenor, and not of isolated passages. As far as a rule on the subject can be laid down, it is, that any work containing matter for which a public indictment or private prosecution could be sustained is not protected by the law, but may be pirated by other parties at pleasure, who, if sued for penalties under the Act, are allowed to give in evidence the nature of the composition which they have published, in order to defeat the action. This is a remarkable exception to the general rule of law, that none shall take advantage of his own wrong; and its operation is quite as remarkable, the effect of the rule having often been to disseminate more widely that which the law has declared not to merit protection.

Besides the special copyrights of the universities secured to them, as before mentioned, by Statute, there still exist certain prerogative copyrights attaching to the owners in perpetuity. Of these the chief belong to the queen, which were more numerous and considerable formerly than at present. The right to print the authorised translation of the Bible without note or comment belongs to the crown, and of this right the Universities of Oxford and Cambridge and the queen's printers are now patentees. Other persons may however print this translation, provided it be accompanied with *bonâ fide* notes (2 Burr. 661). Many other copyrights formerly vested in the crown are now quite obsolete, such as those of almanacs, law-books, and Latin grammars. The crown has a prerogative copyright in the liturgy and other services of the Church, in proclamations, orders in council, and other state papers, and in the statutes. It has been decided that the University of Cambridge shares by letters patent in the crown's prerogative of printing Acts of Parliament. The House of Lords also exercises an exclusive privilege, somewhat fallen into disuse, of publishing its own proceedings as the supreme court of judicature.

The usual modes of legal proceeding to prevent or punish the infringement of copyright, or, as it is more usually termed, piracy, are by action for damages, or for the penalties given by the statute; or more commonly still, by obtaining an injunction in equity to prohibit the unlawful publication, which affords immediate and summary redress. This is always granted where the legal title of the plaintiff to the work is made out, and the identity of the pirated publication with his own shown to the satisfaction of the court. The proof even of an equitable title has been held sufficient to qualify him for this remedy. (Mawman *v.* Tegg, 2 Russ. 385.) Neither will the court be restrained from granting the injunction, by proof that the matter pirated forms only a part of the publication complained of, and that what is original will be rendered useless to the defendant and the public by prohibiting its sale. But as this mode of proceeding presses very severely upon defendants, and often inflicts irreparable injury, the court, where any doubt attaches, will either refuse the injunction altogether, or grant it only on condition of the plaintiff's bringing an action immediately, to have the merits of the case decided by a jury with the smallest possible delay.

A notice of the law of copyright would be incomplete which did not advert to some other compositions which receive from statute a protection analogous to that of literature. Such are engravings, etchings, and prints, maps and charts, and sculpture of all kinds. These resemble written works as regards the incorporeal right in them accruing to the author by the exertion of his mental powers in their production, but differ, as they also require a good deal of his manual skill and labour, and are therefore his property upon the same general principles as any other manufacture. Such productions therefore are even more plainly entitled to the protection of the law than books.

The chief statutes affecting the copyright in works of design, engraving, and etching, are the 8 George II. c. 13, which vest it in the inventor, designer, and proprietor, for fourteen years from the first publication, and enforces this provision against any person pirating the same by forfeiture of the plate and prints, and a fine of five shillings for each print, to be recovered by action within three months of the discovery of the offence. The 7 George III. c. 38, extends the term of copyright to twenty-eight years; and, in addition to the subjects of the former statute, includes maps, charts, and plans, under the same conditions. It also extends the time of bringing an action for the penalties to six months. The 17 George III. c. 57, gives the owner of the copyright a further remedy of action for damages and double costs within the same limits of time. The 6 & 7 Will. IV. extends the provisions of these Acts to Ireland. The 15 & 16 Vict. c. 12, brings lithographs or impressions taken by other means of indefinite multiplication within the provisions of the preceding Acts.

With regard to models, casts, and other sculptures, the 38 George III. c. 71 vests the right and property in these for fourteen years in the proprietor, and gives him a special action on the case against the offender, if brought within six months. These provisions were rendered more effectual by 54 George III. c. 56, by which double costs were given, and an additional term of fourteen years superadded in case the maker should be living at the end of the first term.

As to sculpture certainly, but more doubtfully as to prints, for there have been conflicting decisions on the point, the work must bear upon it the name of the maker and the date of publication to entitle it to the protection of the law.

By the Designs Act, 1850 (13 & 14 Vict. c. 104), provision is made for the registration of productions of sculpture, casts, models, and the like.

With regard to designs for manufactured articles, the 27 Geo. III. c. 38, continued by 29 Geo. III. c. 19, and confirmed and made perpetual by 34 Geo. III. c. 23, gave the sole right of using a new pattern in the printing of linens, cottons, calicoes, and muslins for three months; and the 2 Vict. c. 13 extended this privilege to designs for printing other woven fabrics besides calicoes. The 2 Vict. c. 17 regulated copyright of designs in all articles except lace, and the articles to which the above-mentioned Acts apply. But all these statutes were repealed by the 5 & 6 Vict. c. 100 (amended by 6 & 7 Vict. c. 65), which considerably extended the periods of copyright in designs.

This Act distributes articles to which designs may be applied into twelve classes:—

1. Articles of manufacture composed wholly or chiefly of any metal or mixed metals.
2. Articles of manufacture composed wholly or chiefly of wood.
3. Articles of manufacture composed wholly or chiefly of glass.
4. Articles of manufacture composed wholly or chiefly of earthenware.
5. Paper-hangings.
6. Carpets.
7. Shawls, where the design is applied solely by printing, or by any other process by which colours are or may hereafter be produced upon tissue or textile fabrics.
8. Shawls not comprised in class 7.
9. Yarn, thread, or warp, the design being applied by printing, or by any other process by which colours are or may hereafter be produced.
10. Woven fabrics, composed of linen, cotton, wool, silk, or hair, or of any two or more of such materials, if the design be applied by printing, or by any other process by which colours are or may hereafter be produced upon tissue or textile fabrics; except the articles included in class 11.
11. Woven fabrics composed of linen, cotton, wool, silk, or hair, or of any two or more of such materials, if the design be applied by printing, or by any other process by which colours are or may hereafter be produced upon tissue or textile fabrics, such woven fabrics being or coming within the description technically called furnitures, and the repeat of the design whereof shall be more than twelve inches by eight inches.
12. Woven fabrics not comprised in any preceding class.
13. Lace, and any article of manufacture or substance not comprised in any preceding class.

The Act gives to the proprietor of a design not previously published the sole right of applying it to ornamenting articles of the first, second, third, fourth, fifth, sixth, eighth, and eleventh classes, for three years; to articles of the seventh, ninth, and tenth, for nine months; and to articles of the twelfth and thirteenth classes for twelve months; whether such design be applicable for the pattern, or for the shape and configuration, or for the ornament of the articles, or for any two or more such purposes, and by whatever means the design may be applicable, whether by printing, or by painting, or by embroidery, or by weaving, or by sewing, or by modelling, or by casting, or by embossing, or by engraving, or by staining, or by any other means whatsoever, manual, mechanical, or chemical, separate, or combined. The benefits of copyright of designs are made to depend on registration before publication. Piracy is punished by a penalty of not less than 5*l.* nor more than 30*l.*, to be paid to the proprietor of the design, and to be recovered by an action of debt or for damages, or by summary proceeding before two justices.

The law of patents in many respects resembles that of copyright. [PATENT.]

The Act "for preventing the publication of lectures without consent" (5 & 6 Wm. IV. c. 65) gives to authors of lectures the sole right and liberty of printing and publishing the same, and imposes a penalty on other persons, including printers and publishers of newspapers, who shall print, or publish, or sell them without the author's leave. The Act does not extend to lectures of the delivering of which notice in writing shall not have been given to two justices, living within five miles of the place, two days at least before their delivery, or to any lecture delivered in any university, or public school or college, or any public foundation, or by individuals in virtue of any gift, endowment, or foundation. The Act does not extend to sermons.

COR CA'ROLI, a name given by Halley to the star of the third (or 2½) magnitude in Canes Venatici, in memory of Charles I. It is situated on the neck of the lower dog, and, when figured, has a heart surmounted by a crown. The name is not much in use among astronomers.

COR LEONIS. [REGULUS.]

CORAL FISHERY. Coral (for a zoological account of which see POLYPIARIA, in NAT. HIST. DIV., and other articles there referred to) is a marine production so nearly resembling some plants in appearance, that it is has been supposed to belong to the vegetable kingdom, although it is now known to consist of the cells or habitations of minute animals, so built upon one another as to produce a branched tree-like structure, often very beautiful in form and colour, and exceedingly hard. Being much sought after, especially by the natives of India, for ornamental purposes, coral, in those places in which it is found of good quality, forms an important article of commerce. Coral was known to the ancients under the name *corallium*, or *κοράλλιον*, and as is shown by Pliny's description, they erroneously supposed it to be soft while in the sea, and to harden by contact with the air, or by touching with the hand. (Holland's translation of Pliny's 'Natural History,' book xxxii. vol. ii. p. 429.) It is found abundantly in various parts of the Mediterranean Sea, in the Red Sea, the Persian Gulf, and several other places, in which the coral fishery forms the laborious and dangerous occupation of a large class of men. A full account of the coral fishery in the Straits of Messina is given in the fourth volume of Spallanzani's 'Travels in the two Sicilies' (English translation, 1798, pp. 306–329), from which it appears that the rocks which yield coral are situated in the middle of the strait, and that the parts from which it is taken vary from about 350 to 650 feet below the surface of the water. The coral here grows to about the height or length of twelve inches, and requires eight or ten years to come to perfection. The fishing-ground is therefore divided into several portions, from each of which the coral is removed only once in ten years. When taken at shorter intervals the coral is of smaller size, but it does not appear that it materially increases in length if left for a longer period, although its stems become somewhat thicker. The free access of the rays of the sun through the water appears to be essential to the perfection of the coral, which, we are told, always grows nearly perpendicular to the surface of the rock to which it is attached, whatever the position of the rock itself may be. It is of various colours, from black or brilliant red to a dull white, and varies exceedingly in value, some selling for as much as eight or ten guineas per ounce, while other sorts are not worth a shilling per pound. The mode of conducting the fishery in various places is much the same. In that described by Spallanzani, the instrument used consists of two heavy beams of wood, secured together at right angles in the form of a cross, and loaded at their intersection with stones or other weights sufficient to sink them. A quantity of loosely twisted hemp, intermixed with coarse netting, is attached to the under side of the beams, at the ends of the cross, to the middle of which is secured one end of a strong rope by which the apparatus is let down from a boat, and guided to the spots where the coral is supposed to be most abundant. The branching form of the coral causes it to become entangled in the hemp and network attached to the cross, by which means it is broken off from the rock, and drawn up with the apparatus to the surface of the water. Owing to the great depth at which the fishery is carried on, the submarine movement and drawing up of the cross is a laborious operation, sometimes requiring the united efforts of half a dozen boats; and the men employed are exposed to considerable danger in case of the rope breaking. Other machines are used by the coral-fishers of Marseille, in the fishing-grounds of what is called the "bastion of France;" one of these, called in the Provençal language the *salabre*, is intended for situations in which the bottom of the sea is rough and uneven. With a few trifling variations, however, all the instruments of which we find any account, consist of weighted beams supplied with network, or some substitute for it, to entangle and break off the coral. In some cases a diver descends to guide the ends of the cross into caverns which they would not otherwise enter; and an iron hoop fixed to the beam is occasionally used to break coral from the roof or sides of caverns, a net being attached beneath it to secure what is thus broken off.

Some of the ornamental articles made of coral are very costly. Besides necklaces, and the trinkets called childrens' corals, the material is wrought into bracelets, ear-ring drops, cameos, carvings, and statuettes. The material is very hard, and requires sharp instruments to work it.

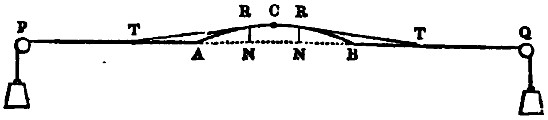
CORANTO. [COURANTE.]

CORBEL, a term used chiefly in Gothic architecture to signify a projecting piece of stone, wood, or iron, placed so as to support a weight of materials. Corbels are sometimes in the form of the modillion or mutule employed in entablatures, and also like the console of a window. Small semicircular towers projecting at the angles on perpendicular surfaces of large towers or other edifices are supported on a series of plain or moulded corbel stones. The weather-mouldings of semicircular windows are often supported in the same manner. The machicolations of towers are almost always supported on corbel stones, as may be observed in the old gates of Southampton, Canterbury, and York. This projecting of one stone beyond another is technically called "corbelling out." This is done in brickwork as well as in masonry. In the interior of some churches the construction of the roof appears to be supported on corbels, the ends of which are often carved, and represent an angel holding a shield. In Norman and Early English architecture the cornice is supported by a row of corbel stones, known as the *corbel-table*, the ends of which are also carved. In old English castles the main beams of the floors were frequently carried on large corbel stones, as at Porchester Castle. The term bracket is sometimes used for a corbel. Bracket, however, is better applied as synonymous with cantilever. Small wooden brackets often differ from corbels and cantilevers in being merely nailed to a perpendicular piece of wood and not having a bearing on a wall, as is always the case with corbels and cantilevers.

CORD, frequently spelt chord, means an elastic string fixed at the two extremities and stretched with force sufficient to enable it to yield a musical note. [ACOUSTICS.] The close analogy which exists between a string and a column of air in a state of vibration would require more space to elucidate properly than this subject will allow us to give: we shall therefore assume some results of mathematical reasoning, point out the probability of those results, and consider the theory of the vibrating cord independently.

Firstly, we suppose our cord to be of uniform thickness and density so that any given length is precisely of the same quality, from what part soever of the string it may be cut. The want of this condition being practically fulfilled is sometimes sensibly felt in violin and violoncello strings, which are then called *false*. A player whose intonation is perfect upon a perfect string, has to learn a new instrument when he attempts to play with a false string; to say nothing of the harmonics which must be heard more or less becoming uncertain, if not discordant.

Let us first suppose a string of indefinite length, and not so acted upon by gravity as to bend downwards, stretched at the two ends by equal weights. The string is a cylinder of uniform diameter and density. Let us next suppose that a part of the string is placed on a mould which catches two points and holds them fast, and stretches the intermediate part into a curve which differs very little from a straight line. Let the mould be suddenly removed, and let us further suppose that, in removing it, we are able to communicate any velocities we please to the different points of the stretched part. We have then, at the moment of starting, a system represented in the following diagram, where A B (dotted) represents the part in question before the mould was applied, and it is A C B the instant the mould is taken away, all the points between A and B being in a state of motion upwards or downwards. The string will not remain an instant in its present state: the first presumption is that the moment the points A and B are set free a disturbance will take place in the parts of the string both between P and A, and between Q and B, the disturbance travelling from A towards P as well as from B towards Q. The first point in which we are interested is this: with what velocity will the disturbance be propagated? and the answer is, that the disturbance travels throughout the string with the same velocity, depending upon its material and the weight with which it is stretched, according to the following law: Let each of the equal weights P and Q be as heavy as c feet of the string; then the velocity of communication is so many feet per second as a bullet would acquire, if it were allowed to fall *in vacuo* down a perpendicular of c feet, or $\sqrt{2 g c}$, where g is the velocity which gravity communicates in one second, or $32\frac{1}{6}$ feet. For instance, let the string be iron wire, every cubic foot of which weighs 7200 ounces avoirdupois. Let the diameter be one-twentieth of an inch, and let the weights P and Q be each 20 pounds or 320 ounces. Then the weight of x feet of the string is ($\frac{1}{20}$ of an inch being $\frac{1}{240}$ of a foot)



$$3\cdot14159 \times (\tfrac{1}{480})^2 \times x \times 7200 \text{ ounces}$$

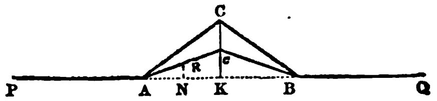
which made equal to 320 gives $x = 3259\cdot5$ feet and

$$\sqrt{2 \times 32\tfrac{1}{6} \times 3259\cdot5} = 457\cdot93 = 458 \text{ nearly,}$$

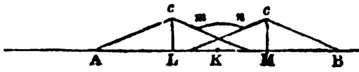
or 458 feet per second is the rate at which the disturbance is communicated.

We now ask what is the nature of the disturbance communicated. It suggests itself as possible, that there may be some species of disturbances which travel only in one direction: for instance, that we might so proportion the velocities of the disturbed points to their positions, that A P should remain undisturbed, that the points from A towards the right should drop one after another into their places, while those from B to Q should be successively disturbed. The answer, again derived from mathematics, is, that such disturbance is possible, and that the conditions under which it will take place are: 1. That C being the highest of the disturbed points, all the points from A to C must be moving *downwards* at the first instant, and all those from B to Q *upwards*. 2. That the velocity of the points must be as follows: At any point R draw a tangent R T to the curve of disturbance. Then the velocity of the point R must be such as would, if continued uniformly, carry the point R from R to N or from N to R in the same time as the whole disturbance is propagated from T to N. These conditions being fulfilled, we may represent the successive states of the string by cutting out a piece of paper of the form A C B, and carrying it along the string P Q at the uniform rate per second which we have found for the propagation of the disturbance. If the directions of the velocities be all reversed, then the disturbance travels from B towards P. Let us call such disturbances *simple;* and with respect to the direction in which they travel, *direct* or *retrograde.* We further learn from mathematical analysis, that any disturbances whatsoever, taking place upon the same points at the same instant, produce a compound disturbance of which the values of R N and the velocities at the point R in the compound disturbances are the algebraical sums of the values of R N, &c., in the component disturbances. And moreover, that any disturbance whatsoever, be the law of its form and velocities what it may, can be compounded of two simple disturbances, one direct and one retrograde. So that the moment the mould is removed, the two simple disturbances will begin to travel in different ways. As long as they have not completely separated, there will be points remaining under the effects of both: but when they have had time to separate completely, we should, were the rapidity of transmission not too great, see the direct disturbance travelling by itself in one direction and the retrograde in the other.

To illustrate this, suppose we wish to ascertain the effect of the disturbance A C B, as drawn, the velocities throughout being nothing at all at the instant the mould is withdrawn. The two simple disturbances which would produce this are two of the form A *c* B, such that at any point R the velocity would bring the point through R N while the disturbance is communicated through A N. If we suppose

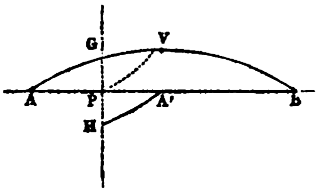


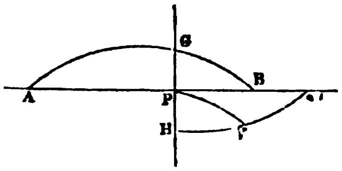
a direct and retrograde disturbance of such a kind, there will be at the first moment no velocity at any point of A C B, since those of the direct and retrograde disturbance compensate each other throughout. But



let a time elapse during which the direct and retrograde disturbances travel to M and L. Then the form of the string at that moment will be A c m n c B, where the part *m n* arises from the composition of the two parts of the disturbances which yet remain acting on the same points.

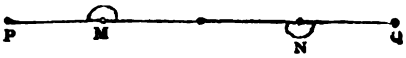
We may thus trace the effect of disturbance upon an indefinitely extended string; but such a string would produce no musical sound, for which it is necessary that there should be a continued reiteration of the same action upon the air repeated at equal intervals. Now supposing a finite string, stretched at the ends, we must ask what takes place when the disturbance comes to the end of the string. And from mathematical analysis again, the following is the answer: Let P be the fixed end of the string, and choose the instant at which,





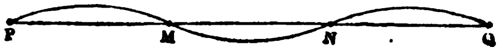
had the string continued, the disturbance would have been B V A. Make a disturbance H A′ equal and opposite to G A, and let it be compounded with G V B, on the supposition that it is part of a disturbance proceeding from P, such as would by itself bend the string in the opposite direction. Then P V B or P V A′ is the state of the string at that instant. In fact, the disturbance is converted into an equal and opposite disturbance proceeding in the contrary direction.

Now let us suppose a string like that of a pianoforte, sharply struck near one end. It is altogether a gratuitous assumption, knowing what we do of the imperfect elasticity of matter, to suppose that the disturbing effect of the blow immediately affects the whole string. A certain disturbance is produced upon a part (it may be a very small part) of the string. Then what is that perceptible phenomenon, the reiteration of which produces a musical tone? Let us suppose the string struck at one-fourth of the length from its end, and suppose that the tension is such that disturbance is propagated at the rate of 2000 feet a second, the length being four feet. A disturbance is produced at M, from which two simple disturbances begin to



travel towards P and Q, at which they are reflected with the same velocities. They will be at N together producing a disturbance (now recompounded) of the same amount as before, but on the opposite side of the string. This takes place while four feet are described at 2000 feet per second, or is repeated 250 times per second. From M to N there is then a succession of effects upon the air, which are most powerful at M and N, owing to the coincidence of the disturbances. This is repeated 250 times in a second, and yields the musical note corresponding to that number of aerial pulsations per second. This is 250 simple vibrations. If we define as a double vibration the time in which the disturbance comes to M again, we should say that there are 125 double vibrations in a second. There is much confusion among writers on this point; some use simple vibrations, or *reversals*; others use double vibrations, or *restorations*.

By supposing the whole string put in vibration, or any simultaneous disturbances communicated to it, the effect may similarly be shown to be, that at the end of the time during which disturbance would be propagated along the whole string the effects are all reversed, but are of the same magnitude; while in a second of such time they are all restored. We thus easily arrive at what is called the fundamental sound of a string. With regard to the harmonics of a string [HARMONICS], they are not so easily shown to be necessary. We shall however, first show that such effects are always possible; that is to say, that if a string begin to vibrate so that its two halves, or its three-thirds, &c., are disturbed together, such an effect will be produced. Suppose, for instance, the initial state of the string to be P M N Q,



where P M, M N, and N Q are the thirds. During the time in which the direct disturbance of P M would be communicated to M N, that of M N would be communicated to N Q, the direct disturbance in N Q would be made retrograde, and so on. Hence though the whole string may vibrate, each of the parts has a vibration by itself in one-third of the time. If we were to modify the vibration of the whole string by compounding with the preceding such a disturbance as would always destroy the velocities at M and N, there would then be three strings, each vibrating in one-third of the time of the whole string. The ear can appreciate such contemporaneous sets of vibrations, and accordingly in this case perceives both the fundamental note of the string and the twelfth above it. If a large and miscellaneous set of disturbances be communicated at once, those only will exhibit cycles of effects which make the halves, the thirds, &c., vibrate together, and we can say little more without entering into mathematics. But in a string it may always be observed that we seldom hear the octave of the fundamental note, and generally the twelfth and seventeenth. No reason can be given for this which is perfectly unobjectionable; we do not know whether it is the aptitude of the ear to distinguish these, or of the string to take the corresponding divisions, which is the cause of the phenomenon.

The time of simple vibration of a string, that is, of complete reversal of all the initial effects, is $l \div \sqrt{2gc}$, where l is the length, and c is as before. It is therefore directly as the length and inversely as the square root of the tension; results which are amply confirmed by experiment.

In all that has preceded we have supposed the string perfectly elastic, and without friction. Neither of these suppositions is true, but since the velocity of propagation of every disturbance is independent of its extent, the gradual diminution of the latter will not affect the phenomenon on which the musical qualities of the string depend.

The method of observing the curves in which each point of a string vibrates, recommended by Dr. Young, was to use a string round which small wire is coiled, like the larger string of a violoncello, and to observe with a microscope the reflection of a candle or other bright spot on one of the coils. Sir J. Herschel suggests that a thin slit should be made in a window-shutter, and that the string should be placed with the point to be examined cutting the vertical plane of light. This point would therefore appear bright while the rest is dark. In either case the rapidity of the vibrations would make the curve described by the bright point permanent.

A single string fitted up for experiments is called a MONOCHORD.

CORDELIERS, so named from wearing a knotted cord for a girdle, were the strictest branch of the Franciscan, or Gray, or Barefooted Friars, established towards the end of the 14th century. Chaucer mentions them in the 'Romaunt of the Rose,' l. 7461. There were ultimately in France, according to Moreri ('Dict. Historique'), no fewer than 284 male and 123 female convents of Cordeliers. A political society, who were opposed to the Jacobins during the French revolution, also assumed this title, from having held its meetings in an old Franciscan convent.

CORDIALS. The beverages known by this name are made of ardent spirits, flavoured with sweetening and aromatic substances. A distiller who produces raw spirits from corn or malt, is not allowed by the excise laws of this country to give any additional or artificial flavour to his spirit; he must sell it in the crude ardent state in which it leaves the still. This is not done out of any consideration in which the consumers are concerned, but simply as a matter of revenue. The distillers rarely if ever sell spirit to the public generally. It is sold to the *rectifiers*, who re-distil it, and impart flavour to it by various means. Cordials are among the liquors which are so treated. Some are made simply by adding essential oils and syrup to diluted spirit; while others are made by adding aromatics to the spirit, boiling and re-distilling it, and sweetening the re-distilled liquor. Some cordials are made from raw spirit, but the best from rectified spirit of wine.

The various cordials are known by the names of the vegetable substance to which they chiefly owe their distinguishing flavours. Hence we hear of aniseed, caraway, cedrat, cinnamon, citron, clove, coriander, lemon, lovage, orange, peppermint, and other cordials.

CORDON, a military term to denote a line of posts and sentries placed around a district or town to prevent any communication between it and the rest of the country. It is chiefly resorted to in cases of any contagious disease having broken out in a place, when it is called a cordon sanitaire; and in order to be effectual, each sentry ought to be able to see his two next comrades right and left.

Cordon in French means also the insignia of an order of knighthood, answering to the English word riband when taken in a similar sense; "cordon bleu," "blue riband," &c.

CORIANDRUM SATI′VUM, *Medical Properties of.* This umbelliferous annual plant is a native of the south of Europe, Tartary, &c.,

and much is imported from the Levant, though a considerable portion is cultivated in Suffolk and Essex, for the use of confectioners in this country. The officinal part is the fruit, improperly called the seed. This is round, white, not unlike a grain of white pepper, and was used as a means of comparison for the manna with which the Israelites were fed in the wilderness. (See 'Exodus' xvi. 31, and 'Numbers' xi. 7.) The fresh fruit has a disagreeable odour, which disappears on drying, leaving a pleasant and peculiar one. The taste is warm and aromatic. The potency depends upon the quantity of volatile oil. Ten pounds of fruit yield six drachms of volatile oil. This oil, which is of a yellowish colour, is not in the Pharmacopœia, but it may be used in the same way as the other distilled waters or oils, as a carminative. Coriander was thought better to disguise the odour and taste of senna than other aromatics, but in the infusion ginger is now substituted for it. Making the infusion with cold water is preferable to either, and avoids the tendency to griping. Coriander is retained as an ingredient of the Confectio Sennæ.

It is necessary to guard against confounding coriander with the seed of the *Daphne Mezereon*, called *Semen Coccognidii*, as the latter is very poisonous.

CORINTHIAN ORDER. [COLUMN.]

CORINTHIANS, ST. PAUL'S TWO EPISTLES TO THE. The First Epistle of St. Paul to the Gentile and Jewish converts to Christianity in the city of Corinth is generally considered by the commentators and critics to have been written A.D. 57-8. Of this opinion are Michaelis, Mill, Whitby, Pearson, Benson, Paley, Adam Clarke, Greswell, &c.; but the date assigned to it by Beausobre, L'Enfant, and Lardner is A.D. 56. The first date appears to be the more correct, for in chap. xvi. v. 8, St. Paul announces his intention of remaining in Ephesus until Pentecost; he then went to Macedonia ('Cor.' ii. ch. ii. 13), and this would bring him to the third or beginning of the fourth year of the reign of Nero, or A.D. 57. The place from which it was written is stated in the concluding postscript to be Philippi, which, as it apparently contradicts the apostle's statement in verse 8, "I shall remain in Ephesus until Pentecost," (*ἐπιμενῶ δὲ ἐν Ἐφέσῳ*), the latter place is commonly given as the more probable; especially as these postscripts appear to be in other instances erroneous, and without authority.

In order clearly to perceive the design of these epistles, it is necessary to observe the following circumstantial facts which gave occasion to the writing of them: Christianity was first preached at Corinth by St. Paul, who resided there about eighteen months, between A.D. 51 and 53. His successors were Apollos, Aquila, and Sosthenes. But shortly after his departure several other learned and eloquent teachers of Christianity drew away most of the Christian converts from the Gospel doctrine as set forth by St. Paul, and formed them principally into two separate parties, the one contending for the rigid observance of the Jewish ritual, the other for indulgence in some of the idolatrous and lascivious customs of the worship of Venus, to whom a magnificent temple, containing a thousand prostitutes (Strabo, Casaub., 378), was dedicated in the centre of this great commercial city, which bore a proverbial character for luxury and licentiousness. Some writers conjecture that the Judaizing preachers of the Gospel in Corinth were some of the twelve apostles; since Paul asserts that on this question he withstood Peter to the face, and (2 Cor. xi. 22, 23) he speaks of these teachers as Hebrews and ministers of Christ. On being apprised of this condition of the Corinthian church, St. Paul wrote his first epistle, the contents of which may be considered under two general heads; first, the reproval of abuses and corruptions which disgraced the Christian community of Corinth; secondly, the reply to various questions, for the decision of which the Corinthians had appealed to the judgment of their apostle. After commencing with the usual salutation, he proceeds therefore to rebuke their schisms and assumption of knowledge and wisdom; exhorting them to become united to himself, as having a prior claim to their respect and attention (c. i. to iv.). He next reproves them for not having delivered unto Satan one who had his father's wife (c. v.); for not suffering themselves to be defrauded rather than go to law; and especially for their indulgence in fornication (c. vi.). Then follow answers to the questions, in which instructions are given concerning marriage, celibacy of virgins and widows, the eating of idolatrous sacrifices, the exercise of supernatural gifts, the proprieties to be observed by public preachers, and the forbidding women to address congregations (c. viii. to xiv.). A censure is passed upon the profane observance of the Lord's Supper, for in eating it, each before another took his own supper, so that while one was hungry another was drunk (*ἕκαστος γὰρ τὸ ἴδιον δεῖπνον προλαμβάνει ἐν τῷ φαγεῖν· καὶ ὃς μὲν πεινᾷ, ὃς δὲ μεθύει*) c. xi. 21. From c. xv. 12, it appears that it was taught among the Christians of Corinth that there is no resurrection of the dead. St. Paul thence takes occasion to expatiate upon the subject to the end of this chapter, which forms the most imposing part of the Church of England Burial Service. The epistle closes with an exhortation to the Corinthians to secure the collection of money for the necessitous saints in Judæa, both hearers and preachers, which is several times enforced with various arguments, especially in c. ix. and xvi., and in c. viii. and ix. of the second epistle, of which we now come to speak.

It is generally agreed that the Second Epistle to the Corinthians was written in 58, about a year after the first, and from Philippi, as the postscript asserts. The main purpose of St. Paul in this epistle was to repel the imputations which it appears his first epistle had induced the opponent teachers to make, alike as to his doctrines, authority, and personal appearance. It is in fact an apologetic oration, in which the apostle enlarges on his spiritual office, power, and qualifications; and speaks of his supernatural revelations, as far exceeding the pretensions of his rivals at Corinth, whom he designates "false apostles, deceitful workers, and ministers of Satan," xi. 13. He explains at length the cause of his not having visited the Corinthians as he promised, declares his great success in preaching, mentions his numerous sufferings and disasters incurred for the sake of the faithful, enforces the necessity of completing the contribution for the saints, and concludes with a farewell salutation.

The great rhetorical merits of this address are critically discussed in the 'Disputatio Inauguralis de alterâ Pauli ad Corinthios Epistolâ,' by M. Royards, 8vo, 1818. All the passages in the fathers of the first three centuries which contain any citation from, or allusion to, these two epistles of St. Paul, are collected in the 2nd vol. of Dr. Lardner's Credibility. The words in the first epistle, *Ἔγραψα ὑμῖν ἐν τῃ ἐπιστολῇ* (c. v. 9), have been the subject of great controversy, as implying that another epistle, not now extant, was written before the one which is called the first. A long list of the critics and divines who have given opinions about it, may be found in Horne's 'Introduc.,' vol. iv. p. 353. Numerous critical particulars may be found in the following works: Michaelis, 'Introduction to the New Testament,' by Bishop Marsh, vol. iv.; Eichhorn, 'Einleitung in das Neue Test.,' vol. iii.; 'Macknight on the Epistles;' Horne's 'Introduction,' vol. iv.; Greswell, 'Harmony of Gospels,' vol. ii.; Paley's 'Horæ Paulinæ;' Barnes, 'Notes Explanatory and Practical on the Epistles to the Corinthians and Galatians;' Jäger, 'Erklärung der beiden Briefe der Apostels Paulus nach Corinth;' Näbiger, 'Kritische Untersuchungen über den Briefe des Apostels Paulus an die Korinthische Gemeinde, mit Rücksicht auf die ihr herrschenden Streitigkeit,' Breslau, 1847. Critical commentaries by Piscator, Rollock, Schlater, and others, are enumerated in Watts' 'Bibliotheca,' where a very copious list is given of sermons on texts from these Epistles, both of which were first printed separately from the Testament by Melancthon at Wittenberg in 1521.

CORK; CORK-CUTTING. The substance commonly known as cork is the outer bark of an evergreen oak, which grows abundantly in Portugal, Spain, the south of France, and Italy. The greatest quantity of cork-bark used in Europe is supplied by Spain and Portugal, but that which is of the best quality is grown in France.

Cork was known and used by the Greeks and Romans, the latter of whom sometimes employed it as we do, for the stopping of casks, and also for the soles to women's winter shoes. (Plin. xvi. 8.)

The careful removal of the outer bark from the cork-tree does not in any way injure it, as this outer bark is really dead bark; on the contrary it is stated that the tree grows more vigorously and lives longer, in consequence of being thus stripped. This operation is first performed when the tree is about fifteen years old, and may be repeated once in every eight or ten years.

The bark obtained by the first stripping is of little or no value; but the produce becomes greater in quantity and better in quality at each successive cutting. The months of July and August are chosen for performing this operation. A cork-tree, thus periodically barked, will live for a century and a half. The inner bark contains a considerable proportion of tannin, but it cannot be removed without killing the tree. This destructive plan is resorted to in Corsica, where the cork-oak is indigenous and abundant. Vast numbers of the trees are cut down every year, the outer bark being used as cork, which, however, is not of good quality: the inner bark being sold, principally at Marseille, to the tanners; and the trunks and branches being burned for the sake of the ashes. It is usual, when cork-bark is taken from the trees, to char it slightly, in order to improve the texture by closing the pores; but this burning occasions that peculiar and disagreeable empyreumatic flavour which is so frequently imparted to liquors which have been stopped by cork thus treated. Some years ago an attempt was made to avoid this evil by using cork-bark which is not so old, the texture of which is so close as not to need the aid of fire; but this bark is too thin for ordinary purposes, and could only be used by cementing two or more layers of it together. The risk of bad flavour was by this means altogether avoided; but, for some reason or other, the plan has not been persevered in.

Cork is light, porous, readily compressible and very elastic. The first-mentioned of these qualities, its lightness, occasions it to be used as floats for fishing-nets, &c. For its more general employment, that of stopping bottles, it is peculiarly fitted by its compressibility and elasticity, while its pores are sufficiently minute to prevent the passage through them of the fluids which it is meant to confine.

In making corks by the ordinary method, the material is entirely shaped by very sharp, smooth-edged broad knives, without the aid of any machinery; it is one of those employments in which everything depends on the manual skill gradually acquired by the workman.

The attempts to make corks by machinery have been very numerous. In one among several American patents for this purpose the quadrangular pieces of cork, cut to proper lengths, are held between two revolving spindles which grip them; and as they revolve, the cork is cut round by a revolving cutter-wheel, the arbor of which is horizontal and has its bearings in a sliding frame. Other apparatus allows the spindles to disengage the cork when cut. The edge of the cutter-wheel is kept sharp during the operation by means of two rotating discs, one acting on each face, and each covered with leather and emery. The blocks or pieces of cork are placed in a box, from which they are taken by a jaw which slides forward and places them between the grips of the revolving spindles.

Another plan was patented a few years ago by Messrs. Cutler and Hancock. A horizontal spindle, running in suitable bearings, carries a hollow conical cutter at each end. The largest end of the cone, which is outwards, is made very sharp; and a small opening lengthwise of the cutter has also a cutting edge, for reducing the cork to a proper size and shape, as it enters the cone. A convenient number of these spindles are mounted in a frame, to which a traversing motion can be given by means of a screw and handle. A rapid motion is communicated to the spindles by a number of belts from a large drum moved by a steam engine or other source of power. Pieces of cork are placed in a holder; and the holder being placed in front of the cutters, with a proper support behind, they are urged forward by the hand screw until the cork has been cut through. The corks, as they are made, are pushed out by rods, which slide within the spindles.

Mr. Gilpee's patented machine for cork cutting, has a cutting blade which has a horizontal reciprocating motion, and which acts upon pieces of cork grasped by rotating holders. Harris's patented apparatus contains a circular toothed cutter, mounted horizontally with a circle of holders; pieces of cork are put into the holders, and the holders receive modified movements while the cutter revolves.

A "Patent Cork Cutting Company" was established a few years ago, for the manufacture of corks by machinery. The patentees averred that the corks so made were both cheaper and better than those made by hand. The same company manufactured cork gun-wadding, used in military services. The speculation was not however successful.

Many substitutes for cork have from time to time been introduced, as stoppers for bottles. Mr. Brockedon has invented bottle-stoppers made of India-rubber. The core of the stopper is made of cotton twisted into strands; several of the strands, lapped with flax thread, are laid together longitudinally, with loose fine cotton roving laid between them. They are then lapped in a cylindrical form with flax thread, and the India-rubber solution applied to it while warm. It is only for peculiar purposes that these stoppers can be used as substitutes for corks; when applied, they must be slightly wetted to make them slide down the inner surface of the neck of the bottle.

Messrs Betts have introduced metallic capsules for covering the mouths of corked bottles. [CAPSULES.]

One of many modes suggested of employing cork for stuffing beds and cushions is that patented a few years ago by M. Bachelard. According to this suggestion, the cork is used in the state of saw-dust or shreds, instead of in bulk. Any mode of preparing it may be adopted, provided the cork be in very small fragments. It may be used alone, or combined with wool or horsehair. The patentee states that if a substratum of the cork be covered with a layer of horse-hair or wool, we shall have all the smoothness of a horse-hair or wool mattrass, combined with the lightness and elasticity of cork. When used at sea, such a mattrass might be light enough to act as a life-preserver, in case of exigency. Mr. Ritchie has introduced an ingenious mode of using cork in beds, mattrasses, &c.; and also in hats.

CORN-LAWS AND CORN-TRADE. From a very early period of our history the corn-trade of the country was the subject of legislative interference and restriction. At first, and while the kingdom was thinly peopled, it was deemed good policy, in order to insure a sufficient supply of food for its inhabitants, to forbid the exportation of corn, while its importation was freely permitted; but, in later times, during which the population had increased with a rapidity rarely seen in long-settled countries, the policy of the legislature was altogether different. The object then sought was to stimulate home production by prohibiting importation, or by restricting it in such a degree as to secure to the native farmers a monopoly of the home market, and its ultimate aim was professed to be the securing of a constant sufficiency of a principal article of food, independent of all foreign countries, by means which should insure to the home grower an adequate return for the capital and skill employed. It needs no argument now to show that the policy of our ancestors was ill calculated to insure the end which they had in view, that of providing a sufficiency of cheap food for the common people.

The earliest statute extant upon this subject is the 34th Edw. III., c. 20, passed in 1360-61, by which it was enacted, that "the passage of corn shall be prohibited in all the ports of England, so that none have licence nor warrant to pass with such corn in anywise, unless it be to Calais or Gascoigne, or to other special places which it behoveth that the king cause to be furnished with the corn of England, and that at his own ordinance and licence."

The phraseology of this act has led to the supposition that exportation was previously illegal, except with a licence from the king, and that the object in framing this law was to define and restrict the royal prerogative in this particular. In 1394 another act was passed (17 Richard II., c. 7) of a somewhat contrary tendency. By this new law licence is granted by the king—such are the terms of the act—"to all his liege people of his realm of England, to ship and carry corn out of the said realm, to what parts that please them, except to his enemies, paying the subsidies and devoirs thereof due, notwithstanding any ordinance, proclamation, or any defence (prohibition) made before this time to the contrary; nevertheless he will that his council may restrain the said passage when they shall think best for the profit of the realm." This act was confirmed in 1425 by the act 4 Henry VI., c. 5. Eleven years later it was thought necessary to fix a limit in regard to the price at which the liberty to export should cease, and that limit was declared (15 Henry VI., c. 2) to be 6*s.* 8*d.* per quarter for wheat, and 3*s.* per quarter for barley. This act was passed for only a limited time, and had expired, when, in 1441, on the meeting of parliament, it was renewed in the following terms: "Our sovereign lord the king, forasmuch as this statute is not now in his force, and that many counties adjoining to the sea may not sell the substance of their corn but by carriage and bringing by the sea, hath ordained, that the statute and ordinance aforesaid, now expired, shall begin to hold his force at the Feast of the Nativity of our Lady next ensuing, and shall endure from thence till the parliament next to be holden after the same feast, so that a parliament be holden within ten years next ensuing after the first beginning of this present parliament, and if so that there be no parliament holden within the same ten years, that then it shall continue and endure till the end of the same ten years:" in 1444 this act was "ordained to be perpetual, and stand in his force for ever" (23 Henry VI., c. 5).

The limited permission thus given to export their produce must be attributed to the increasing power of the land owners; and it may be taken as evidence that the cost of production in this kingdom was at least equally moderate with the cost in neighbouring countries, that in all this time no attempt was made to prohibit or restrict the importation of the produce of other countries. Such a restriction was, however, imposed in 1463 by the statute 3 Edward IV., c. 2, which on the plea that "the labourers and occupiers of husbandry within this realm of England be daily grievously endamaged by bringing of corn out of other lands and parts into this realm of England, when corn of the growing of this realm is at a low price," enacts that "no person, from the feast of Saint John the Baptist next ensuing, shall bring into England any wheat, rye, or barley, not of English or Irish growth, unless the price of wheat shall exceed 6*s.* 8*d.* the quarter, that of rye 4*s.*, and that of barley 3*s.*, on pain of forfeiture of the grain." The statutes here mentioned, by which the prices were established at which the importation and exportation of corn were respectively to cease, continued in force until 1534, when a new act (25 Henry VIII., c. 2) prohibits, except by licence from the crown, the exportation of grain, the reason for which alteration is thus quaintly expressed in the preamble to the act: "Forasmuch as dearth, scarcity, good, cheap, and plenty of cheese, butter, capons, hens, and other victuals necessary for men's sustenance, riseth and chanceth of so many and divers occasions that it is very hard and difficile to put any certain prices to any such things, no person or persons, unless it be by licence under the king's great seal, from henceforth shall carry or convey any corn, beeves, muttons, veals, porks, or any other of the above said victuals to any parts beyond the sea, except only for the victualling the towns of Calais, Guinnes, and the marches of the same, and except for victualling of ships passing the seas." The civil wars which preceded the accession of Henry VII. had caused much land to be thrown out of cultivation, and the act of 1534 was probably occasioned by the consequent diminution of produce, but this attempt failed, as it necessarily must, to increase the supply of grain, which effect would best have been brought about by a removal of all restriction. Such a course would have ill agreed with the imperfect ideas upon such subjects which then prevailed; but as the evil was increased during the next seventeen years, and it was thought necessary to apply some remedy, the statute 5 & 6 Edward VI., c. 5, was then passed. This statute is entitled, "An act for the maintenance and increase of tillage and corn," and it enacts that thenceforth at least as much land should be tilled in every parish as had been under the plough at any time since the accession of Henry VIII., under a penalty, to be exacted from the parish, of 5*s.* for every acre that should be deficient. The general permission to export grain, which had been taken away in 1534, was restored in 1554 (1 & 2 Philip & Mary, c. 5), whenever the prices were at or under 6*s.* 8*d.* per quarter for wheat, 4*s.* for rye, and 3*s.* for barley. The preamble to this act makes it appear that it was passed, not in consequence of the prevalence of any sounder views of public economy, but because it was found impossible to prevent exportation, and it was thought that better success would attend the regulation than the prohibition of the trade. In 1562 an alteration in the law was made, by enlarging the limits of the prices which governed exportation, and these were fixed at 10*s.* per quarter for wheat, 8*s.* for rye, and 6*s.* 8*d.* for barley; and nine years later it was enacted (13 Eliz., c. 13) that corn might be exported on payment of certain specified duties at all times when no proclamation had been issued to the contrary. The law of 1463 had all this time been in existence, prohibiting importation while the prices of wheat, rye, and barley should be under 6*s.* 8*d.*, 4*s.*, and 3*s.* respectively; but the prices that had for some time prevailed rendered this law inoperative, and the law of 13 Elizabeth therefore gave virtual freedom to the trade in corn.

In the succeeding reigns, and up to that of William and Mary, this system was continued, but accompanied by various modifications as regards the limiting prices and the rates of duty chargeable. The prices at which export was permitted were from time to time enlarged, until, in 1670, wheat might be shipped away at any time when the price did not exceed 53*s.* 4*d.* per quarter. At the same time import duties were imposed, so heavy as to amount to a prohibition, the object of these regulations being to keep the price of wheat always as high as 53*s.* 4*d.* per quarter for the advantage of the land-owners. Not satisfied, however, with this degree of favour, this powerful class succeeded in 1689 in procuring an Act (1 Will. & Mary, c. 12) whereby they secured the payment of a bounty amounting to 5*s.* per quarter on the exportation of wheat when the price did not exceed 48*s.* per quarter; and bounties according to the same scale were granted for the export of barley and other grain.

Not content with interposing obstacles to a free trade in corn with other countries, our ancestors thought fit to place restrictions upon that trade within the kingdom. It was imagined, that if the consumers could be brought to deal immediately with the growers, the profit of intermediate dealers would be saved. Under this impression, both parties looked unfavourably upon those dealers; the sellers imagining that they could obtain better prices, and the buyers that they could purchase cheaper but for the middlemen, while the common people were easily led to believe that the dearths which then frequently occurred were attributable to the practices of the dealers in buying up corn and withdrawing it from the market. An Act was passed, declaring it to be an offence to buy corn in one market with intent to sell it again in another; and persons guilty of this offence, to which the name of *engrossing* was given, were punished with imprisonment and the pillory. By a statute of Elizabeth, no person was permitted to convey corn from one part of the kingdom to another, unless he had a licence for the purpose, the right of granting or withholding which was confided to the magistrates in quarter sessions. These restrictions were modified in 1624, and by the act 15 Charles II. c. 7, the engrossing of corn was made legal whenever the price of wheat did not exceed 48*s.* per quarter. So recently as the year 1800, when the price of wheat exceeded 100*s.* per quarter, engrossing however has been held to be an offence at common law, and a corn-dealer was convicted of it, but was not brought up for judgment.

The Act of 1689 was modified in 1773, by reducing to 44*s.* per quarter the price at which the payment of bounty was to cease, and in 1815 the granting of bounty was discontinued by law. In fact no bounty could have been claimed at any time after 1792, in which particular year the average price for the whole year was below the price fixed in 1773. At that time (1773) importation was permitted upon payment of the nominal duty of 6*d.* per quarter whenever the price should be above 48*s.* This permission was considered injurious to their interests by the land-owners, who, on the plea that the country might become dependent upon foreign countries for its supply of food, succeeded in 1791 in obtaining an Act whereby the price at which importation was allowed at 6*d.* per quarter was raised to 54*s.*, a duty of 2*s.* 6*d.* was imposed when the price was between 50*s.* and 54*s.*, and 24*s.* 3*d.* per quarter was charged when the price was below 50*s.* A new law, passed in 1804, shifted the price at which the prohibitory duty of 24*s.* 3*d.* was charged to 63*s.*; between that price and 66*s.* the duty was 2*s.* 6*d.*; and above 66*s.*, only 6*d.* per quarter. Under the Act of 1791, the maritime counties of England were divided into twelve districts, and importation and exportation were regulated in each district by their respective prices; but in 1804 this plan was altered, and the aggregate average of the twelve districts was taken as the measure for regulating importation and exportation to and from the kingdom.

A bill for raising the duties on importation, which was brought into the House of Commons in 1814, met with so much opposition that it was abandoned; but in the following year an Act was passed, after great opposition, and exciting great clamour on the part of the people, allowing the free importation of corn from foreign countries, in order to be warehoused or re-exported, but forbidding the importation for consumption, unless the average prices were, for wheat, 80*s.*; for rye, peas, and beans, 53*s.*; for barley, 40*s.*; and for oats, 26*s.* Every description of corn might be brought for consumption from the British colonies, when the prices were,—for wheat, 67*s.*; rye, peas, and beans, 44*s.*; barley, 33*s.*; and oats, 22*s.* The deficient harvests of 1816 and 1817 raised the prices above these limits, and so much grain was imported free of duty that a considerable surplus was left for future and more abundant years. One of these years of abundance occurred in 1822, and during the next twelve months the prices of grain fell below what they had been in any year since 1792. It was expected, on the part of the land-owners, that the effect of the Act of 1815 would have been to keep the price of wheat steady at or about 80*s.* per quarter; but this expectation was so far from being realised that, if we except the years of scarcity 1816 and 1817, the average price of the period which elapsed before the system of prohibition was exchanged for that of a graduated duty in 1829, was only 58*s.* 5*d.* per quarter. In the mean time, by an Act passed in 1823, the law of 1815 was modified so as to allow of importation whenever the prices were,—for wheat, 70*s.*; for rye, peas, and beans, 46*s.*; for barley, 35*s.*; and for oats, 25*s.* per quarter; but a duty of 17*s.* a quarter for wheat (and other rates in proportion for other grain) was to be payable during the first three months of importation, and 12*s.*, &c., thereafter. The prices of corn were never such during its continuance as to bring this Act into operation. In 1825 the importation of wheat from the English colonies in North America was legalised upon payment of a duty of 5*s.* per quarter, without reference to the price in the English market. In 1826, a long-continued drought caused great apprehensions concerning the coming harvests; and in order to prevent the opening of the ports to fresh importations, and the consequent probable admission of a quantity of corn beyond the actual wants of the country, by which prices would have been affected perhaps for years after, permission was given to the government to admit by proclamation 500,000 quarters of foreign wheat then warehoused in the kingdom.

The inconvenience of the system of alternate prohibition and unlimited importation was at length fully recognised by all parties, and in 1829 an Act was passed (9 Geo. IV. c. 60) to regulate the trade in corn. The principle of this Act was, the constant freedom of importation upon the payment of duties fluctuating according to the average price of grain, decreasing as the price advances, and increasing as the price falls. This was the celebrated "sliding-scale" introduced and carried by Sir Robert Peel. The following table exhibits the scale of duties graduated according to the average prices of the different kinds of grain.

WHEAT.

When the price shall be—	per qr.
62*s.* and under 63*s.* per qr.	24*s.* 8*d.*
63 ,, 64 ,,	23 8
64 ,, 65 ,,	22 8
65 ,, 66 ,,	21 8
66 ,, 67 ,,	20 8
67 ,, 68 ,,	18 8
68 ,, 69 ,,	16 8
69 ,, 70 ,,	13 8
70 ,, 71 ,,	10 8
71 ,, 72 ,,	6 8
72 ,, 73 ,,	2 0
above 73*s.*	1 0
under 62*s.* and not under 61*s.*	25 8

and in respect of each integral shilling, or any part of such integral shilling, by which such price shall be under 61*s.*, such duty shall be increased by 1*s.*

OATS.

When the price shall be 25*s.* and under 26*s.* per qr., 9*s.* 3*d.* duty; and in respect of every integral shilling by which such price shall be above 25*s.*, such duty shall be decreased by 1*s.* 6*d.* until such price shall be 31*s.* Whenever the price shall be above 31*s.*, the duty shall be 1*s.* Whenever such price shall be under 25*s.* and not under 24*s.*, 10*s.* 9*d.*; and in respect of each integral shilling, or any part of each integral shilling, by which such price shall be under 24*s.* the duty shall be increased by 1*s.* 6*d.*

BARLEY.

When the price shall be 33*s.* and under 34*s.* per quarter, 12*s.* 4*d.* per quarter duty; and in respect of every integral shilling by which such price shall be above 33*s.*, such duty shall be decreased by 1*s.* 6*d.*, until such price shall be 41*s.*, and whenever the price shall be at or above 41*s.*, the duty shall be 1*s.* per quarter. Whenever the price shall be under 33*s.* and not under 32*s.*, 13*s.* 10*d.*; and in respect of each integral shilling, or any part of each integral shilling, by which such price shall be under 32*s.*, the duty shall be increased by 1*s.* 6*d.* per quarter.

RYE, PEAS, AND BEANS.

When the price shall be 36*s.* and under 37*s.* per quarter, 15*s.* 6*d.* per quarter, and in respect of every integral shilling, by which the price shall be above 36*s.*, the duty shall be decreased by 1*s.* 6*d.* until such price shall be 46*s.* When the price shall be at or above 46*s.*, 1*s.* When the price shall be under 36*s.* and not under 35*s.* per quarter, 16*s.* 9*d.*; and in respect of each integral shilling, or any part of each integral shilling, by which such price shall be under 35*s.*, the duty shall be increased by 1*s.* 6*d.* per quarter.

On the 7th of May, 1841, an abortive attempt was made by the ministry of the day to establish a fixed duty of 8*s.* the quarter on the importation of foreign wheat. The dissolution of parliament, which took place very shortly after this proposition, was unfavourable to the ministry. However, on the 9th of February, 1842, their successors brought forward a measure for a modification of the corn law of 1828, which was successfully carried, and came into operation on the 29th of April following.

Under the Act 9 Geo. IV. c. 60, which lasted from the 15th of July, 1828, to the 29th of April, 1842, the total quantity of foreign wheat admitted was 13,562,856 quarters and 4,305,150 cwts. of foreign wheat-flour, and, in addition, at a lower rate of duty, 597,700 quarters of colonial wheat and 1,744,591 cwts. of colonial flour. Nearly one-half of the foreign wheat and flour was admitted at the lowest rate of duty, and comparatively little at the higher rates, as the following statement will show:—

Duty at	Qrs. Wheat.	Cwts. Wheat-flour.
1*s.*	5,788,045	1,758,372
2*s.* 8*d.*	2,880,613	862,262
6*s.* 8*d.* . . .	1,997,226	519,123
10*s.* 8*d.*	820,342	243,120

The average rate of duty was under 6*s.* the quarter. For the whole period during which this Act was in operation the average price of wheat in England and Wales was 59*s.* 4*d.*, and the extreme points of fluctuation in the weekly averages were from 36*s.* 8*d.* to 81*s.* 6*d.*, or 122 per cent. The highest yearly average was 70*s.* 8*d.*, in 1839; and the lowest 39*s.* 4*d.*, in 1835. In 1838 the duty underwent thirty different changes. The scale of duties was so constructed as to offer great inducements to the holders of foreign wheat to withhold supplies until the duty had reached the lowest point; and a rise in prices, at one particular point, of only one shilling, brought down the duty four shillings. It was often stated that prices were fictitiously raised in order that the dealers might gain by the diminished duty; but the strong motives for all holders of wheat to keep back supplies, operated much in the same way, without any fraud on their part. In a single week, when the lowest duty has been attained, above 1,500,000 quarters of wheat have been liberated from the bonding warehouses, the holders of which had resolutely resisted the prevailing high prices until this object had been accomplished. The following was the scale of prices and rates of duty for foreign wheat and wheat-meal under the Act 5 Vict. c. 14:—

Wheat.		Wheaten Flour or Meal.	
Average per Qr.	Duty per Qr.	Duty per Cwt.	Duty per Barrel.
s. *s.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
under 51	1 0 0	0 6 10½	0 12 0⅜
51 „ 52	0 19 0	0 6 6⅜	0 11 5⅛
52-3-4 „ 55	0 18 0	0 6 2¼	0 10 10
55 „ 56	0 17 0	0 5 10⅛	0 10 2¾
56 „ 57	0 16 0	0 5 6	0 9 7½
57 „ 58	0 15 0	0 5 1⅞	0 9 0¼
58 „ 59	0 14 0	0 4 9¾	0 8 5
59 „ 60	0 13 0	0 4 5⅝	0 7 9⅞
60 „ 61	0 12 0	0 4 1½	0 7 2⅝
61 „ 62	0 11 0	0 3 9⅜	0 6 7⅜
62 „ 63	0 10 0	0 3 5¼	0 6 0⅛
63 „ 64	0 9 0	0 3 1⅛	0 5 5
64 „ 65	0 8 0	0 2 9	0 4 9¾
65 „ 66	0 7 0	0 2 4⅞	0 4 2½
66-7-8 „ 69	0 6 0	0 2 0¾	0 3 7¼
69 „ 70	0 5 0	0 1 8⅝	0 3 0
70 „ 71	0 4 0	0 1 4½	0 2 4⅞
71 „ 72	0 3 0	0 1 0⅜	0 1 9⅝
72 „ 73	0 2 0	0 0 8¼	0 1 2½
73 and upwards .	0 1 0	0 0 4⅛	0 0 7¼

The lowest duty in the above scale is not reached by jerks, as in the former one, and the "rest" between 66*s.* and 69*s.* was an important modification. One hundred and thirty-eight new towns were added in the new Act to the one hundred and fifty which returned the average prices under the Act of 1828. From July, 1842, to January, 1843, inclusive, the average price of wheat in the 138 new towns was 53*s.* 8*d.*; in the 150 old towns, 52*s.* 6*d.*; making an aggregate average of 52*s.* 10*d.* The importations of wheat which took place under the Act 5 Vict. c. 14, from April 29th, 1842, to 5th April, 1843, were:—

	Foreign.	Average Duty.	Colonial.	Average Duty.
Wheat . .	2,623,478	8*s.* 5*d.*	37,886	1*s.* 11*d.*
Wheat-flour, cwts.	524,491	2*s.* 11*d.*	602,868	0*s.* 7*d.*

Under the Act of 1828 the duties on colonial wheat were 5*s.* when the price here was under 67*s.*, and 6*d.* when at or above 67*s.* the quarter. The Act 5 Vict. c. 14, fixed the duties on colonial wheat as follows: When the price here was under 55*s.* the quarter, the duty was 5*s.*

55*s.* and under 56*s.* . . . . . duty 4*s.*
56*s.* „ 57*s.* . . . . „ 3*s.*
57*s.* „ 58*s.* . . . . . . „ 2*s.*
58*s.* and upwards . . . . . . „ 1*s.*

All the efforts, however, to maintain corn at an equable price were vain. At length, in 1845, the potato-rot in Ireland created serious apprehensions of a famine in the United Kingdom, close approaches to which had already been felt in Ireland. On November 22, Lord John Russell wrote a letter from Edinburgh declaring himself in favour of a total repeal of the corn-laws. On December 4, the 'Times' announced that the ministry had resolved to assemble Parliament early to take the corn-laws into consideration, with a view to their abolition; but on the 10th, the ministers resigned, and Lord John Russell received the Queen's commands to form a new administration. This, in the face of a parliament elected almost for the purpose of sustaining protection, he was unable to effect, and on Dec. 20, Sir Robert Peel re-accepted office. In the meantime the Anti-Corn-Law League commenced its operations, and numerous meetings were held, at which Mr. Cobden and Mr. Bright attended, and large subscriptions were raised, in order to effect their object of promoting freedom in the corn trade. Meetings were also held by large bodies of labouring agriculturists, and on Jan. 3, 1846, addresses were presented to the Queen by the corporations of London and Dublin praying her to open the ports for the importation of corn duty free. On Jan. 22, the parliament was opened by the Queen, who, in her speech, after alluding to the failure of the potato crop, noticed the prosperous state of the revenue as a proof of the wisdom of former measures passed for the relaxation of protective duties, and suggested whether the "principle might not be yet more extensively applied," and further reductions and remissions made. On Jan. 27, in a committee of the whole House, Sir Robert Peel developed his plan for removing all the restrictive duties on the importation of corn, and substituting instead a fixed duty of one shilling per quarter on all corn imported, whatever the price might be, and at the same time reducing and modifying the duties on other articles of food. A vehement opposition was raised against the measure in the House of Commons, which, during its progress, degenerated into violent attacks on the personal character and motives of Sir Robert Peel; but after a series of debates and several divisions, the third reading was carried on May 15, by 327 votes against 229. On May 18, the bill was introduced into the House of Lords by the Duke of Wellington, and after a series of animated debates, and in the face of an earnest opposition, it was passed on June 25, without a division, the opponents having been outvoted on several amendments that had been proposed by them during the discussion. The bill received the royal sanction on June 26. On the 25th Sir Robert Peel had been defeated on the Protection to Life in Ireland Bill, and on the 29th he announced his resignation, having succeeded in carrying this most important measure.

It will have been seen that for a long series of years England exported grain, and efforts were made to encourage the exportation. In 1689, an Act was passed allowing a bounty of 5*s.* per quarter when exported, if the home price did not exceed 48*s.* per quarter; but in 1773 the home price was reduced to 44*s.* per quarter before the bounty was allowed. This bounty was not abolished by Act till 1815, though the price at home had been so high as to negative its effects, except in 1792, when the yearly average was only 41*s.* 9*d.* per quarter. In fact, from 1790 England ceased altogether to be an exporting country. In 1800 and 1801, there were two bad harvests, and in the latter year wheat reached the unprecedented price of 115*s.* 11*d.* per quarter, and the quantity imported in the two years was 2,638,866 quarters. This occasioned a greater cultivation of land, and from 1800 to 1809 there were 847 inclosure bills passed. In 1810 there was another deficient harvest, and 1,491,341 quarters were imported. In 1812, though the price of wheat advanced to 122*s.* 8*d.* per quarter, only 244,385 quarters were imported. In 1818, on the contrary, when the average price was only 83*s.* 8*d.* per quarter, there were imported 1,503,518 quarters. The framers of the law of 1829 intended it to prevent fluctuations in the price of English grain, but in the seven years, notwithstanding the provision, the price varied from 75*s.* 3*d.* in 1829 to 36*s.* 8*d.* in 1835, descending regularly every year; while in the three years, 1829, 1830, and 1831, there were imported 4,557,736 quarters. In fact, the Act was a total failure, as far as regarded protection to the agriculturist, while it acted very injuriously to the population of the kingdom by artificially raising the price of bread, without any corresponding advantage to the revenue; for the great bulk of the importations was always brought in at a low rate of duty. The total quantity imported, however, kept increasing, with occasional exceptions; but in 1845, waiting the repeal of the duty, the importation was only 1,142,700 quarters, of which only 315,615 were taken for home consumption. In 1846, after the repeal, there were imported 1,437,944 quarters, and 1,995,852 were taken for home consumption. In 1847, there were imported 2,650,058 quarters; besides 6,329,646 cwts. of wheat-meal, 3,614,687 quarters of Indian corn, and 1,451,020 cwts. of Indian corn-meal. In 1848, there were imported 2,594,013 quarters of wheat, 1,765,475 cwts. of flour, and 1,586,781 quarters of Indian corn. In 1849, there were imported 3,872,134 quarters of wheat, 3,371,801 cwts. of flour, 2,247,424 quarters of Indian corn, and 102,173 cwts. of Indian corn-meal. In 1850, there were imported 3,754,593 quarters of wheat, 3,855,050 cwts. of flour, 1,286,264 quarters of Indian corn, and 11,401 cwts. of meal. In 1851, the importations were, wheat 3,833,636 quarters, flour 5,363,478 cwts., Indian corn 1,819,782 quarters, and meal 9,562 cwts. In 1852, they were, wheat 3,068,892 quarters, flour 3,889,583 cwts., Indian corn 1,479,891 quarters, and meal 742 cwts. In 1853, they were, wheat 4,945,314 quarters, flour 4,646,400 cwts., Indian corn 1,552,934 quarters, and meal 15,581 cwts. In 1854, there were imported 3,431,222 quarters of wheat, and 3,646,505 cwts. of flour. In 1855, the importations were, wheat 2,667,702 quarters, and 1,904,224 cwts. of flour. In 1856, they were, wheat 4,072,833 quarters, flour 3,970,100 cwts., Indian corn 1,777,813 quarters, and meal 7,880 cwts. In 1857, they were, 3,417,957 quarters of wheat, 2,178,148 cwts. of flour, 1,150,783 quarters of Indian corn, and 1092 cwts of meal. In 1858, they were, 4,275,435 quarters of wheat, 3,890,252 cwts. of flour, 1,762,320 quarters of Indian corn, and 4720 cwts. of meal. The average price of wheat per quarter was 69*s.* in 1856, 56*s.* 7*d.* in 1857, and 44*s.* 4*d.* in 1858.

The principal supplies of foreign corn to Great Britain are drawn from Russia, Prussia, Denmark, Mecklenburg, the Hanse Towns, Spain, Turkey, Wallachia, Moldavia, Egypt, the United States, occasionally rather large quantities, especially as flour, from France, some from our own American colonies, and small quantities from various other places. Russia, Prussia, and the United States are the principal contributors. The total computed value of all the corn and meal imported in 1858, including oats, barley, and all the other species, was 19,992,971*l.*

CORN-RENT is a money-rent varying in amount according to the fluctuations of the price of corn. In some countries rent is paid in the produce of the land itself; but in no part of the United Kingdom does this primitive custom exist. Some landlords in Ireland, indeed, for the accommodation of their tenants, were accustomed to accept corn in payment of their rent, at the price of the nearest market, and ship it to England for sale; but the rent is calculated in money. (See Appendix F to 'First Report of Poor Laws (Ireland) Commissioners,' 1836, p. 221.)

A corn-rent is founded upon the principle that a farm being assumed to grow, upon an average, a certain quantity of produce, the value of such proportion of that produce as may be agreed upon shall be paid to the landlord as rent. But as the prices of all produce are liable to considerable variation, and as the profits arising from the land must generally be mainly dependent upon the prices for which the produce is sold, it is supposed to be equitable to the farmer that the money value of that portion of the produce which he pays as rent should be calculated so as to vary with prices, instead of being determined by any arbitrary or unvarying standard. And it is undeniable that with long leases a corn-rent is a security against the growth of any serious disproportion between the rent originally agreed upon and the actual value of the produce of the land. If the farmer, under the security of a long lease, lay out capital upon the land and thus increase the quantity of produce, he derives the entire benefit arising from increased production, as the quantity to be paid as rent has already been agreed upon; and he is secured against loss caused by a fall in prices, as the amount of his rent is governed by prices.

For the purpose of assessing a corn-rent the average price of wheat alone, or of wheat and other grain, is taken—sometimes for the last year, and sometimes for a certain number of years. If the price for one year only be taken, the results to the farmer may be thus stated:—When prices are low from a limited demand for produce, his rent is reduced; and when they are low from increased production, his rent is still reduced, although he has more produce than usual to sell. When prices are high from an increased demand, he has more rent to pay, but the remunerative prices enable him to pay it easily; but when an advance of prices is caused by scarcity, his rent is raised, while the high prices may be counterbalanced by the diminished quantity of produce which he has to sell. Thus in three cases out of four a corn-rent is favourable to the farmer; and even in the fourth case he is secured from loss by its favourable operation in other years. In some leases also a further advantage is given to him by fixing a maximum price: and thus if prices should happen to rise beyond that point, he derives the whole profit accruing from the difference. Under this system of annual averages, so advantageous to the farmer, there is a certain degree of unfairness to the landlord, which is sometimes corrected by assessing rent upon the average price of different kinds of produce for a certain number of years; by which means a just proportion is maintained between the money-rent and the average annual value realised from the land. It is upon this principle that the tithe rent-charges are calculated, from the average price of grain for seven years [TITHES]; and corn-rents are sometimes regulated by the scale of average prices published annually for the purposes of the Tithe Commutation Act. In Wiltshire some farms are let in this manner, but their number is inconsiderable. The rent of grazing and dairy farms cannot be regulated by the ordinary system of corn-averages; but in some of the dairy farms of Cheshire the rent is determined by the average price of wheat and of cheese. In many parts of the south of Scotland corn-rents are paid according to the *fiar* prices of corn, as determined in each county by a jury summoned by the sheriff for that purpose.

The principle of a corn-rent is by no means of recent origin; for by an act 18 Elizabeth, § 6, it was required that in all future leases granted by the colleges in the universities of Oxford and Cambridge, and by the colleges of Winchester and Eton, one-third part at least of the old rent shall be reserved and paid in good wheat at 6*s.* 8*d.* the quarter or under, and good malt at 5*s.* the quarter or under: or shall be paid in ready money after the rate of the best wheat and malt sold at the nearest market.

(*Journal of the Royal Agricultural Society*, vol. v. pp. 84, 177; see also Index to *Report on Agricultural Distress*, 1836.)

CORN-TRADE, ANCIENT. The production of corn, one of the chief necessaries of life, and its commercial exchange, have been a subject of the first importance in all ages. It is proposed here to state briefly the general nature of the trade in corn among two of the states of antiquity to whom we are mainly indebted for our knowledge of the economical condition of ancient times. There are few important political questions at the present day to which we cannot find something similar in former times; and the blunders of ancient legislation may still be instructive to modern statesmen.

Athenian Corn-Trade.—The small and comparatively barren territory of Attica did not produce sufficient corn for the consumption of the inhabitants. Corn was brought into the Piræus, the port of Athens, from the countries bordering on the Black Sea, Syria, Egypt, and other parts of Africa, and from Sicily. Demosthenes asserted (B.C. 355) that the Athenians imported more grain than any other people ('Against Leptines,' c. 9). But the trade in corn between Greece and the Black Sea was of some magnitude at a much earlier date. In B.C. 480, Xerxes, while at Abydos, on his way to the invasion of Greece, saw the corn-ships that were sailing from the Black Sea and through the Dardanelles and carrying corn to Peloponnesus and Ægina. (Herodotus, vii. 147.) Some parts of the country on the coast of the Black Sea now export grain, and probably have exported grain ever since the time of Xerxes.

The importation of grain into Attica was a matter that was protected and regulated by the state; and instances are mentioned of armed ships convoying the corn-vessels from the Black Sea to the Piræus. The exportation of corn from Attica was forbidden; and only one-third of the foreign corn that was imported into the Piræus could be re-exported to other countries: this law as to importation was enforced by the overseers of the harbour. The law interfered with the trade in corn in other ways also, with the intention apparently of keeping prices low: but with what success it is easy to conjecture. Engrossing or the buying-up of corn was a serious offence: a man could not purchase more than fifty loads (called *φορμοί*). The amount of these loads cannot be exactly ascertained, nor is it material: the principle is clearly shown by the limitation. The penalty for violating this law was death. Boeckh ('Public Economy of Athens,' Eng. trans.) states the law thus: "In order to prevent the accumulation and hoarding of corn, engrossing was very much restricted; it was not permitted to buy at one time more than fifty such loads as a man could carry." According to this a man might buy fifty loads as often as he pleased at different times. But the meaning of the passage of Lysias is that a man must not buy up corn so as to have on hand more than fifty loads at a time. This interpretation is consistent with the Greek, and the other is not; and it is not open to the same kind of objection that Boeckh's interpretation is.

The absurdity of the Athenian legislation on the trade in corn appears from a speech of Lysias against the corn-dealers (*Κατὰ τῶν Σιτοπωλῶν*). The corn-dealers were generally aliens, and their business made them objects of popular detestation: it was alleged that they bought up corn, and refused to sell it when it was wanted, and thus compelled the buyers to pay them their own price. Yet it is stated by Lysias that the law was, that a dealer must sell his corn only one obolus dearer (the medimnus?) than he bought it. Thus the law attempted to fix the maximum profit of the dealers. But they evaded the law, according to the same authority, by selling it a drachma (six oboli) higher on the same day: the meaning of the orator here is not quite clear. The orator states that the hope of great gain made the dealers run the risk of the extreme penalty of the law. He urges the court which was then sitting for the trial of some of the corn-dealers whom he was prosecuting, to enforce the penalty against them, and so make them mend their manners; and he represents both the consumers and the importers of corn as suffering from the combinations of the dealers. A more signal instance of absurdity and commercial ignorance is not extant than this oration.

To carry the laws as to the sale of corn into effect, the Athenians had corn wardens (*σιτοφύλακες*) who kept an account of the corn that was imported, inspected flour and bread, and saw that they were sold of the weight and at the price fixed by law.

Various enactments were made with a view of securing a supply of corn; such as that no money should be lent on a vessel which did not bring back to Athens a return cargo of goods, among which corn was mentioned; and that no person living in Attica should import corn to any place except the port of Athens. The interest of individuals, and ultimately the real interests of the community, were thus set in opposition to the supposed interests of the state, and evasions of the laws are often spoken of. Individuals attempted what they will always do, to sell their grain at the dearest market. (Xenophon, 'Œconom.,' c. 20.)

There were public corn-warehouses at Athens, in which corn was lodged that had been purchased at the expense of the state, and sometimes, as it appears, by private contributions. There were officers appointed to purchase the corn (corn-buyers, *σιτῶναι*), and persons to give or measure it out (*ἀποδέκται*). Corn so purchased was probably sold to the people at a low price, and sometimes also there were gratuitous distributions of it, as at Rome; and occasionally, as at Rome also, presents of grain were received from foreign princes or rich persons, and distributed among the people gratis.

This subject has been investigated by Boeckh, 'Public Economy of Athens,' translated by Mr. (now Sir) G. C. Lewis, 2nd edition, revised, 1842; and these remarks are mainly founded on what is said there. The subject is curious, but unfortunately we must collect our information mainly from detached passages of the Athenian orators, who deal largely in falsehood and exaggeration, and it is not possible to arrive at certainty on some points.

Roman Corn-trade.—What we know of the ancient corn-trade of Italy mainly relates to the city of Rome. From an early period it belonged to the administration to see that the city was duly supplied with grain. The immediate neighbourhood of Rome did not supply the wants of the city, and grain was imported into Rome from the country of the Volsci and from Cumae soon after the establishment of the consular government. (Livy, ii. 9.) An importation of corn from Sicily is mentioned by Livy (ii. 41) under the year B.C. 486. As the Romans extended their empire, and provincial governments were formed, such as those of Sicily and Sardinia, supplies of grain were got from foreign parts. After the conquest of Sicily, the proprietors were allowed to keep their lands on condition of paying a tenth of the produce to the Romans, according to the system which had been established by King Hiero. Sardinia, after the conquest, paid the same. (Livy, xxxvi. 2.) The mode of proceeding, as to the tenths in Sicily, was this: the cultivator gave notice of what quantity of land he intended to sow, and an entry was made of it. The Roman state took the tenth of the produce in kind, which the cultivator was bound to convey to some port in Sicily, where it was embarked for Rome. All the wheat produced by the tenths was entered in the public books, and it was all conveyed to Rome or to the armies which were serving in parts remote from Rome; this at least appears to have been the general rule.

Sometimes two-tenths of the produce were claimed by the Roman state (Livy, xxxvi. 2; xxxvii. 2), but in this case the second tenth was paid for out of the Roman Aerarium. Presents of grain from foreign states and princes were sometimes made to the Romans. (Plutarch, 'C. Gracchus,' c. 2.) Thus it appears that the state undertook to provide the chief supply of grain for the city: the grain was sometimes sold, and sometimes distributed gratis among the poor, a practice which became common under the late republic. Besides these distributions of corn at the public expense, the wealthy Romans who sought popularity sometimes made like distributions of corn among the poorer citizens, as M. Crassus the Rich did in his consulship. (Plutarch, 'Crassus,' c. 2, 12.)

It does not appear, then, that the chief supply of corn for the city of Rome during the republic was furnished in the regular way of trade. It was the business of the state to keep the proper supply of corn for the city in the public warehouses; but the supply was not always equal to the demand, and it also often happened that many people could not afford to pay the price. Scarcity was not uncommon both under the republic and the empire.

In Livy (iv. 12) we have a notice of the creation of a Præfectus Annonæ, or superintendent of provision, L. Minucius, B.C. 440, in a season of scarcity. He exercised his office in an arbitrary manner, by compelling persons to state what corn they had in their possession, and to sell it; and he endeavoured to raise a popular clamour against the corn-dealers, if Frumentarii here means private dealers. Cn. Pompeius Magnus was intrusted with the superintendence of provision for five years. (Cicero, 'Ad. Attic.,' iv. 1.) Augustus, at the urgent importunity of the people, took on himself the office of Præfectus Annonæ, such as Pompeius held it. (Dion. Cassius, liv. 1.)

Under the early republic many parts of Italy were well cultivated, and Rome, as already observed, derived supplies of corn from various parts of the peninsula. But the civil wars which devastated Italy near the close of the republic were injurious to agriculture. Murder and proscription thinned the numbers of the people, and life and property were insecure. Many of the lands changed owners, and the property of those who were cut off by violence fell into the hands of others, and chiefly of the soldiers. These and other causes made Italy less productive about the time of the Christian era than it had been some centuries earlier. Even under the peaceable administration of Augustus, 60,000,000 modii of wheat were annually imported into Italy and Rome from Egypt and the Roman province of Africa. The modius is estimated at 1 gallon and 7·8576 pints, English measure. But this did not prevent scarcity: there was a great famine at Rome in the latter part of the administration of Augustus. (Dion Cassius, lv. 26; Vell. Paterc., ii. 104; Suetonius, 'Augustus,' c. 42.) The general administration of Tiberius, the successor of Augustus, is commended by Tacitus. ('Annal.,' iv. 6.) He endeavoured to secure a proper supply of corn by intrusting to the Publicani the management of the tenths of grain from the provinces; but there was a great famine in his time, and the high price of grain almost caused an insurrection. The emperor showed that he had not neglected this important part of the administration: he published a list of the provinces from which corn was brought, and he proved that the importation was larger than in the time of Augustus. (Tacit., 'Annal.,' vi. 13.) Again, under the administration of the Emperor Claudius, a famine in Rome occurred. (Tacit., 'Annal.,' xii. 43.) Tacitus observes, that during the scarcity Claudius was assailed with menaces while he was seated on the tribunal in the forum, and he only escaped by the aid of his soldiers. He adds that there were only fifteen days' provisions in the city; and "formerly Italy used to export supplies for the legions to distant provinces; nor is Italy now barren, but men prefer cultivating Egypt and Africa, and the existence of the Roman people is intrusted to ships and the dangers of the sea." Claudius subsequently paid great attention to the supplying of Rome with corn. Under Nero, the successor of Claudius, there was a famine at Rome. (Suetonius, 'Nero,' c. 45.)

The comparison of ancient and modern prices of grain is a difficult subject, and the results hitherto obtained are not satisfactory. It is also necessary to be careful in considering the circumstances when any prices are mentioned. P. Scipio on one occasion (B.C. 200) sent a great quantity of corn from Africa, which was sold to the people at four ases the modius. (Livy, xxxi. 4.) In the same book of Livy (c. 50) another sale is mentioned at the rate of two ases the modius. But on these, as on many other occasions, these prices were not the market-prices at which wheat would have sold, but they were the lower prices at which the state sold the grain in order to relieve the citizens. Rome, both under the republic and the early empire, suffered occasionally from scarcity or from high prices of grain. It is possible that a supply might have readily been procured from foreign parts if there had been a body of consumers in Rome to pay for it. But the export of grain to Rome was not a regular trade; it was, as above explained, a system by which the Romans drew from their provinces a contribution of corn for the consumption of the capital, and it was not regulated by the steady demand of an industrious class who could pay for it. The reign of Tiberius appears to have been a period of scarcity; the complaints were loud, and the emperor fixed the price of corn in Rome, and he promised to give the merchants a bounty of two sesterces on the modius. This seems to mean that the emperor fixed the prices for all grain, including whatever private merchants might have; but to make them amends for any loss, he paid them part of their prices out of the treasury. After the fire at Rome, in the time of Nero, Tacitus speaks of the price of corn being lowered to three sesterces the modius. The Emperor Diocletian, by an edict, fixed the prices of all articles through the Roman empire. The reason for this measure is stated, in the preamble to the edict, to be the high market-price of provisions, which is attributed to the avarice of the dealers, and was not limited even when there was abundance. (Inscription of Stratoniceia; see an Edict of Diocletian, fixing a maximum of prices throughout the Roman empire, A.D. 303, by Colonel Leake, London, 1826, 8vo.)

It does not appear whether the grain which was brought to Rome from the provinces was brought in public ships, or in private ships, by persons who contracted to carry it. There seems, however, to be no doubt that there was also importation of corn by private persons, and that there were no restrictions on the trade, for the object was to get a full supply. A constitution of Valentinian and Valens ('De Canone Frumentario Urbis Romæ,' Cod. xi., tit. 23) declares that merchants (nautici) were to make a declaration of the grain which they imported before the governors (of provinces) and the magistrates, and that they had only good corn on board; and it was the business of the authorities to see that the grain was good. The provisioning of Constantinople, Alexandria, and probably other great cities, under the later empire, was subject to regulations similar to those of Rome, and there were public granaries in those cities.

It is almost impossible to collect from the scattered notices in the Roman writers a just notion of the nature of the trade in grain. So far as concerns Rome, we can hardly suppose that there was a regular trade in our sense of the term. The chief supply of grain was provided by the state. That which is best left to private enterprise was undertaken by the government. It is true that the condition of Rome was peculiar under the late republic and the empire. The city was full of paupers, who required to be fed by occasional allowances of corn. The effect, however, of the state purchasing for the people was not a certain supply, but occasional scarcity. Whether a state undertakes to buy for the people what they want for their consumption, or regulates the trade by interfering with the supply, is immaterial as to the result. In either case the people may expect to be starved whenever corn is scarce. The Roman system was to import all that could be got into Rome, but it was not left to private enterprise. There was no exclusion of foreign grain in order to favour the Italian farmer; nor can it be said that the Italian farmer suffered because foreign grain was brought into Rome and other parts of Italy; he could employ much of his land better than in growing corn for Rome and sending it there. Corn came from countries which were better adapted to corn-growing than many parts of Italy; and besides this, the transport of grain from many foreign parts to Rome, such as Sardinia, Sicily, and the province of Africa, would be as cheap as the transport of grain by sea from the remote parts of Italy, and much cheaper than the transport by land.

The essay of Dureau de la Malle, 'De l'Economie Politique des Romains,' and the treatise of Vincentius Contarenus, 'De Frumentaria Romanorum Largitione,' in Grævius, 'Antiq. Rom. Thesaurus,' vol. viii., contain most of the facts relating to the supply of corn to Rome; and both have been used for this article.

CORNET, a commissioned officer in a regiment of cavalry. He is immediately inferior to a lieutenant, and his rank corresponds to that of an ensign in a battalion of infantry.

The word is derived from the Italian *cornetta*, signifying a small flag; and hence, both in the English and French services during the 16th and 17th centuries, it was applied not only to the officer who had charge of the standard, but to the whole troop, which seems then to have consisted of a hundred men and upwards, and to have been commanded by a captain.

CORNET, a shrill wind instrument formed of wood, which seems to have been known from the earliest times, and continued in use until the latter part of the 17th century, when it was laid aside for the oboe. In the 'Musurgia' of Luscinius is a rude wood-cut of the cornet; but it is represented in a more satisfactory manner in Mersenne's 'Harmonie Universelle,' from which it appears that the instrument was blown by a mouth-piece, and that there were treble, tenor, and base cornets. The compass of the first was from A, the second staff in the treble, to E in alt. The last was bent in rather a serpentine form, and reached nearly five feet in length, therefore was deep in tone.

CORNET-STOP, in the organ, is an imitative treble-stop, consisting of five ranks of pipes, in organs on a large scale, each key of the instrument causing all the five pipes to sound at once. These are tuned to a given note, its octave, twelfth, fifteenth, and seventeenth, though the whole together produce the effect of a single note. This is a harsh stop, and is now used only in union with others; but formerly, compositions called *Cornet Pieces*, were written exclusively for it; these have been proscribed by an improved taste in organ-playing.

CORNICE. [COLUMN.]

CORNIN. A bitter crystallisable matter, found in the bark of the root of the *Cornus florida*.

CORNS are in the first instance merely thickenings of the cuticle, generally of the toes, arising from continued pressure over a projecting portion of bone. While superficial, a corn is moveable, and retains the lamellated structure of the cuticle; afterwards it acquires a base, attaches itself more firmly to the subjacent parts, and becomes a complete corn. "A bursa or bag of synovial membrane, similar to those bursæ which are of original formation, but of very small size, is formed between the thickened cuticle and the cutis; it is this combination of thickened cuticle with a subjacent bursa which constitutes a perfect corn." Corns are either hard and dry, which is the case when they are situated externally; or they are soft, when situated between the toes. The inconveniences arising from corns are generally slight; sometimes they are very serious. The bursa under a hard corn is apt to suppurate, and the inflammation, pain, and irritation, are excessive. Tight or improperly-shaped shoes being the primary cause of corns, shoes or boots fashioned to the natural shape of the foot must be worn, and the material of which they are formed should be soft and pliant. To avoid pressure upon a corn already existing, a portion of leather spread with diachylon or other emollient plaster having a hole in it corresponding with the size of the corn may be worn; or if the outer portion of the corn, which is quite insensible, be pared or scraped away, temporary relief is obtained. For a corn which has become very sensible, the application of lunar caustic or concentrated nitric acid is necessary; if there be reason to suspect the existence of an inflamed bursa containing pus, the outer portion must be cut away with the scalpel, and the bursa freely laid open, so that the matter may escape, which will give great relief. If a soft corn become very sensible, as it often does, without an abscess existing beneath, concentrated nitric acid should be applied. Bunions differ from corns, inasmuch as the part affected is generally of greater extent; a bursa is always connected with them, and when inflamed, serum is secreted, which, if pressure and all causes of irritation be avoided, is again speedily absorbed. If the bursa be much inflamed, leeches and fomentations are necessary; and should pus have formed, it must be let out. If the abscess do not speedily heal, nitric acid should be carefully applied to its inner surface. Extirpation of corns has been recommended, but it is not free from danger, and should never be attempted except by a very skilful and dexterous person. A wound or laceration of the tendons or fibrous structures around the joints, is sometimes followed by the most alarming symptoms, even by tetanus and death. Amputation of the toe has been practised. (See Sir B. Brodie's excellent Lecture on Corns and Bunions, 'Medical Gazette,' February 13th, 1836.)

CORNUCO'PIA, or CORNU-COPIÆ, the horn of plenty, fabled to have had its origin in the infant days of Jupiter; it was filled with the fruits of the earth, and was endowed with the property of always becoming spontaneously furnished with a new supply. Ovid, in his 'Fasti' (lib. v. 115-128), tells us that one of the goats of Amalthea, who nursed Jupiter in Crete, broke off its horn against a tree, when the nymph, having wreathed it with flowers and filled it with fruit, presented it to the god. Jupiter, when he came into power, called his nurse to the skies, and made the horn the emblem of fertility. The Greeks called it *κέρας Ἀμαλθείας, the horn of Amalthea*. In his 'Metamorphoses' (lib. ix. v. 82, &c.), Ovid derives the origin of the Cornucopia from a different fable. He speaks of it as the horn of the river-god Achelous, broken off by Hercules, and consecrated by the Naiads:—

> "Naïdes hoc, pomis et odoro flore repletum,
> Sacrarunt."

The Cornucopia was the proper symbol of Tyche or Fortune, but it was also carried by the several lesser deities of the Romans who presided over the needs and destinies of the people. In representations of the deities the cornucopia usually rests on the left arm. Only three or four statues of Roman goddesses are known which have the original cornucopiæ remaining; of these one is in the Museum of the Vatican, another in that of Dresden, and a third in the Museum at Naples. Statues of Roman empresses bearing cornucopiæ are, however, not uncommon. On Roman or Græco-Roman relievi goddesses are often represented with cornucopiæ. Cornucopiæ are also often figured on vases in the hands of both male and female deities; they occur likewise very frequently in the types of ancient coins, particularly upon those of Sicily.

The beautiful medal of Arsinoë, wife and sister of Ptolemy II. Philadelphus, Greek king of Egypt, given in the article ARSINOË, in the BIOG. DIV., has a cornucopia on the reverse.

COROLLARY (Corolla, "a little crown,") is frequently used for any necessary consequence of a proposition; but technically applied in geometry, it means a consequence which immediately follows from the demonstration of a proposition, without the necessity of introducing any other proposition. But all the corollaries in our editions of Euclid are annexed by editors, none of them being in the original. Those of book i., prop. 32, were added by Campanus; but the first use of the word which we know of is in the English translation by Billingsley.

CORO'NA. [COLUMN.]

CORO'NA BOREA'LIS AND AUSTRA'LIS, the northern and southern crowns. The first is a northern constellation, found in Aratus, who says it was formed by Bacchus in memory of Ariadne. It is situated between Bootes and Hercules, and the bright star of its cluster (marked α) may be seen about an hour eastward of Arcturus, and about eight degrees nearer to the pole. Corona Australis is a southern constellation, first found in Ptolemy. It is situated between the front legs of Centaurus.

The following are the principal stars in *Corona Borealis*.

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
β	3	5098	4
θ	4	5131	4
α	5	5143	2
δ	10	5244	4

There are no bright stars in *Corona Australis*.

CORONATION, the act of crowning or consecrating a king. This rite is of remote antiquity, as may be gathered from the notices which we have in Scripture, in the first and second books of Kings, of the coronations of Solomon, and of Joash the son of Ahaziah, of the latter of whom it is expressly said that Jehoiada the priest took him, put the crown upon his head, and gave him the testimony, and they made him king, and anointed him. The act of anointing seems to have originated with the Jews.

In England, after the kingdoms of the Heptarchy had become united, we find the ceremony of coronation continually alluded to in the Saxon Chronicle, under the term ʒehalʒoð, by which is expressed that the king was hallowed or consecrated. Kingston-upon-Thames was the place where the Saxon sovereigns were crowned during nearly the whole of the 10th century. (See Diceto and the other historians in the 'Decem Scriptores.') Edgar, who succeeded to the throne in 959, is said to have been crowned either at Kingston or at Bath. Edward the Confessor was crowned at Winchester in 1042. The copy of the Gospels upon which the Saxon kings were sworn at their coronations is believed to be still preserved amongst the Cottonian Manuscripts in the British Museum, in the volume Tib. A. ii. Harold and William the Conqueror were crowned at Westminster. It was customary with the Norman kings to be crowned more than once. Henry II. crowned his eldest son, and associated him with himself in the administration during his own life.

In one or two instances, in the Norman times, we find the regnal years of our kings dated from their coronations only; the previous time, between the predecessor's death and the performance of the inaugural ceremony, was considered as an interregnum. This is a fact of no small importance to those who would accurately fix the dates of public instruments and transactions in the reigns of Richard I., John, and their successors.

The first English coronation of which we have any detailed account is that of Richard I., in the Histories of Diceto and Bromton. (See Twysd., 'Script.' x. coll. 647, 1157.) An account of all the formalities observed at that of Richard II., taken from the 'Close Rolls,' is to be found in Rymer's 'Fœdera,' the old edition, vol. vii. p. 157. Froissart has given a short but interesting narrative of the coronation of Henry IV., which the reader may see in the English edition of his 'Chronicle,' by Lord Berners, 4to., London, 1812, vol. ii., pp. 753, 754. The details of the English coronations of Henry V. and VI., and of the latter in France, are contained in the Cottonian Manuscripts, Tib. E. viii. and Nero C. ix. Hall and Grafton have described the ceremonies at the coronation of Richard III. The account of the coronation of Henry VIII., with the king's oath prefixed, interlined and altered with his own hand, is likewise preserved in the Cottonian Manuscript already mentioned, Tib. E. viii. The oath, with its interlineations, is engraved in fac-simile in the first volume of the second series of Ellis's 'Original Letters illustrative of English History.' Fuller, in his 'Church History,' and Ellis's 'Letters,' 1st Ser., vol. iii. p 213, detail the particulars of the coronation of Charles I. Several editions of the Form and Order of Charles II.'s coronation at Scone in 1651 were published at the time in 4to, at Aberdeen; reprinted at London in folio, 1660; and the entertainment of Charles II. in his passage through London to his coronation, with a narrative of the ceremony at the coronation, by John Ogilby, with plates by Hollar, fol., London, 1662. Sandford's 'History of the Coronation of James II.,' fol., London, 1687, illustrated with very numerous engravings, is the most complete of all our works upon English coronations published by authority. That of George IV., of which two portions only appeared, was far more splendid, with coloured plates, but remains unfinished. In this work the oath taken by the sovereign on his or her coronation is given at length.

A very ancient MS. of the ceremonial of crowning the emperors at Aix-la-Chapelle was purchased at the last sale of Prince Talleyrand's libraries, by Mrs. Banks, and is now among the additional manuscripts in the British Museum. Of foreign published coronations that of Charles V. at Bologna as emperor, in 1530, is one of the most curious, engraved in a succession of plates upon a roll of considerable length. The 'Sacre de Louis XV., Roy de France et de Navarre, dans l'Eglise de Reims, 25 Oct. 1722,' is a work of pre-eminent splendour, full of finished engravings. The 'Description of the Ceremonies at the Coronation of Napoleon as Emperor of France, with his Consort Josephine, 2 Dec. 1804,' is a work of equal size, but the engravings are chiefly in outline: folio, Paris, 1807. There is a volume, with engravings, of the coronation of the empress Anne of Russia, fol., Petersburg, 1731; and many others might be enumerated.

The formulary which has served for the general model for the

English coronations since the time of Edward III. is the 'Liber Regalis' deposited in the archives of the dean and chapter of Westminster, and kept with a religious care. It is supposed to have been written for the particular instructions of the prelates who attended at the coronation of King Richard II. and his queen. Copies of this manuscript, without its illuminations, are preserved in one or two of our manuscript libraries. The substance of the ceremonial directed in it is abridged in Strutt's 'Manners and Customs,' vol. ii.

CORONER. The coroner (*coronator*) is an ancient officer by the common law of England. The name is said by Lord Coke to be derived "*a coronâ*, because he is an officer of the crown, and hath conusance of some pleas which are called *placita coronæ*." In this general sense the chief justice of the Court of King's Bench is by virtue of his office the supreme coroner of all England, and may, if he pleases, hold an inquest, or otherwise exercise the office of coroner, in any part of the kingdom. Lord Coke mentions an instance in which Chief Justice Fineux in the reign of Henry VII. held an inquest on the body of a man slain in open rebellion, 5 'Reports,' 51. In this sense also, the Master of the Crown Office in the Court of King's Bench, is styled the "coroner or attorney for the king;" his business being confined to pleas of the crown discussed in that court. But the officers now usually understood by this term are the coroners of counties, who are of high antiquity, being said in one of the most ancient treatises on the common law to have been ordained together with the sheriffs to keep the peace of counties when the earls gave up the wardship. ('Mirror,' c. i. § 3.) In early times too, the office appears to have been one of great estimation; for by the statute 3 Edw. I. c. 10, they are required to be knights, and by the 28 Edw. III. c. 6, they must be "of the most meet and most lawful men of the county." By the 14 Edw. III. st. 1. c. 8, "no coroner shall be chosen unless he have land in fee sufficient in the county, whereof he may answer to all manner of people." No peculiar qualification is now required, though Serjeant Hawkins seems to express an opinion that the persons chosen, though not knights, must be "of good substance and credit." (Hawkins's 'Pleas of the Crown,' book ii. cap. 9.) Most commonly there are four coroners in each county; but the number varies according to the usage of different counties. There have been recent instances in which, upon a representation made to the lord chancellor by the magistrates, that the existing number of coroners was insufficient for the business of the county, writs have issued for the election of additional coroners. (See 3 Swanston's 'Reports,' 181.)

Coroners of counties are elected by the freeholders in the county court, in the same manner as sheriffs and conservators of the peace formerly were; the election takes place by virtue of an ancient king's writ, *De Coronatore Eligendo*, returnable in chancery. The 58 Geo. III. c. 95, which made provision for conducting the election of coroners similar to those then in existence for the election of knights of the shire, was repealed in 1844 by 7 & 8 Vict. c. 92, which substituted other regulations on the ground that the former mode of election was inconvenient and attended with great and unnecessary expense. This Act applies only to county coroners, and the coroners of the city of London and borough of Southwark, of the Queen's household and the verge of the Queen's palace, and Admiralty coroners, are specially exempted. Counties may be divided by the justices into two or more districts for the purposes of this Act, and alterations may be made in existing divisions. The justices, in making such divisions, are in the first place to petition her majesty, and notice is to be given to each coroner by the clerk of the peace of the time when the justices will take such petition into consideration. Any coroner of the county may present a petition to her majesty touching the proposed division or alteration of districts. Her majesty, with the advice of the privy council, may order that such county shall be divided into so many districts as may be considered convenient, and determine at what place within each district the court for the election of coroner for such district shall be held. The justices are to direct the clerk of the peace to make out a list of the several parishes, townships, or hundreds in each of the coroner's districts into which the county is divided, specifying the place within each district at which the court for the election of coroner is to be held, the place or places at which the poll is to be taken, and the parishes or places attached to each polling-place. The justices may then assign one district to each coroner; and whenever a vacancy occurs, the election is to be made in the manner prescribed by the Act. The coroner must reside in the district for which he is elected, or in some place wholly or partly surrounded by such district, or not more than two miles beyond its outer boundary; the election must be made in the district; and the coroner chosen by a majority of persons duly qualified who shall reside in such district; no voter can poll out of the district where his property lies. Within not less than seven or not more than fourteen days after the sheriff shall have received the writ *De Coronatore Eligendo*, he is required to hold in the district for which a vacancy has occurred a special county court for the election; and if a poll be demanded, it may be kept open for two days, eight hours each day, from eight o'clock in the morning. The sheriff is to erect polling booths; poll-clerks are to be sworn; and an inspector of poll-clerks is to be appointed on the nomination of each one of the candidates. Electors may be required by or on behalf of any candidate to make oath respecting their qualification. The result of the poll is to be declared by the sheriff. The coroner, although elected for a district, is to be considered as a coroner for the whole county; but he is only to hold inquests within his own district, except in case of the illness or unavoidable absence of the coroner for another district; and his inquisition must certify the cause of his holding such inquest.

Coroners in counties are elected for life; but if they accept an office incompatible with the duties, such as that of sheriff, or dwell in a remote part of the county, or are incapacitated by age or infirmity, they are removable by means of the writ *De Coronatore Exonerando*; and by the stat. 25 Geo. II. c. 29, § 6, they may be removed upon conviction of extortion, wilful neglect of duty, or misdemeanour in their office. The great seal has authority however, independently of the above statute, to remove coroners for neglect of duty. (1 Jacob and Walker's 'Reports,' 451.) By the stat. 7 & 8 Vict. c. 92, coroners are prohibited from acting professionally in any case in which they have sat as coroner.

At common law the coroner had authority to hear and determine felonies; but his powers in this respect were expressly abrogated by Magna Charta, cap. 17. The most usual duty of a coroner is that of taking inquisitions of death; and though his duties, as well as his authority in this respect, are said to have existed at common law, they are declared by the 4 Edw. I. stat. 2, commonly called the statute *De Officio Coronatoris*. By the directions of that statute, "the coroner, upon information, shall go to the places where any be slain, or suddenly dead or wounded, and shall forthwith command four of the next towns, or five or six, to appear before him in such a place; and when they are come thither, the coroner, upon the oath of them, shall inquire in this manner; that is to wit, if they know where the person was slain, whether it were in any house, field, bed, tavern, or company, and who were there; who are culpable, either of the act or of the force; and who were present, either men or women, and of what age soever they be, if they can speak, or have any discretion; and how many soever be found culpable, they shall be taken and delivered to the sheriff, and shall be committed to the gaol; and such as be found and be not culpable, shall be attached until the coming of the judge of assise." And it is declared by the same statute, that "if it fortune any such man be slain, which is found in the fields or in woods, first it is to be inquired whether he were slain in the same place, or not; and if he were brought and laid there, they should do so much as they can to follow their steps that brought the body thither, whether he were brought upon a horse or in a cart. It shall also be inquired if the dead person were known, or else a stranger, and where he lay the night before." It is declared also by the same statute, that "all wounds ought to be viewed, the length, breadth, and deepness; and with what weapons; and in what part of the body the wound or hurt is; and how many be culpable; and how many wounds there be; and who gave the wound." In like manner it is to be inquired by the coroner "of them that be drowned, or suddenly dead, whether they were so drowned or slain, or strangled by the sign of a cord tied straight about their necks, or about any of their members, or upon any other hurt found upon their bodies. And if they were slain, then ought the coroner to attach the finders and all other in the company." The provisions of this ancient statute are still in force, and are to be followed by coroners in all their particular directions as nearly as possible at the present day in inquisitions of death. In case of a death happening upon the high sea, inquisitions are taken before the Admiralty coroner, who is appointed by the king or the Lord Admiral; and the county coroners have in such a case no jurisdiction. The inquisitions taken before the Admiralty coroner are returned to the Commissioners of the Admiralty under stat. 28 Hen. VIII., c. 15.

The coroner has authority to assemble a jury by means of a precept to the constables of the hundred or adjoining township, and under the 7 & 8 Vict. c. 92, jurors and witnesses who neglect to attend an inquest may be fined any sum not exceeding 40*s*. The power, however, of punishing witnesses who refuse to give evidence for contempt of court, and the right to exclude persons from his court, are incidents of his office. When the jury are assembled, they are charged and sworn by the coroner to inquire, upon view of the body, how the party came by his death. The jury are, by the 6 & 7 Will. IV. c. 86, amended by the 21 & 22 Vict. c. 25, to inquire into the particulars required for the registration of deaths, and the coroner informs the registrar in writing of the finding and other particulars, and in case of a dead body being found exposed, he must give notice to the registrar. By the 18 & 19 Vict. c. 108, he must also give previous notice to the secretary of state, of inquests on deaths from accidents in coal mines. The coroner has no authority to take an inquisition of death, except upon view of the body by himself and the jury; and if he does so, the inquisition is wholly void. (Rex *v.* Ferrand, 3 Barn. and Ald. 'Reports,' 260.) If a body liable to an inquest has been buried before the coroner has notice of the circumstances of the death, he has authority to cause it to be disinterred for the purpose of holding the inquest, provided he does so within a reasonable time. By the stat. 7 Geo. IV. c. 64, § 4, which repeals an ancient enactment on this subject, it is provided that "every coroner, upon any inquisition before him taken, whereby any person shall be indicted for manslaughter or murder, or as an accessary to murder before the fact, shall put in writing the evidence given to the jury before him, or as much thereof as shall be material; and shall have authority to bind by recognisance all such persons as know or declare anything material touching the said manslaughter or murder, or the said offence of being accessary to murder, to appear at the next court of oyer and terminer, or gaol delivery, or superior criminal court of a county palatine, or great sessions, at which the trial is to be, then and there to prosecute or give evidence against the party charged; and every such coroner shall certify and subscribe the same evidence, and all such recognisances, and also the inquisition before him taken, and shall deliver the same to the proper officer of the court in which the trial is to be, before or at the opening of the court." And by a subsequent section, authority is given to the court to which the inquisition ought to be delivered to examine in a summary manner into any offence committed by the coroner against the act, and to punish him by fine. The coroner's inquisition may be removed into the Court of Queen's Bench, and the facts found may be traversed by the personal representative of the deceased; or the court may make it for any apparent defect.

For every inquisition taken in any place contributing to the county rates, the coroner is entitled to a fee of 20*s.*, under the 25 George II. c. 29, and by the 1 Vict. c. 68, to an addition of 6*s.* 8*d.* He is also entitled to 9*d.* for every mile he is obliged to travel from his usual place of abode for the purpose of taking it, to be paid by order of sessions out of the county rates; and by the 7 & 8 Vict. c. 92, coroners may be paid travelling expenses, although in the exercise of their discretion they may have deemed it unnecessary to hold an inquest. By the act 6 & 7 Will. IV. c. 89, the coroner is empowered to order the attendance of legally-qualified medical practitioners upon an inquisition of death, and to direct the performance of a *post mortem* examination; and if the majority of the jury are dissatisfied with the first examination, they may call upon the coroner to summon a second medical witness, to perform a *post mortem* examination, whether it has been performed before or not. The same statute also, as amended by the 1 Vict. c. 68, requires the coroner to pay a fee of one guinea to such witness, if he has not performed a *post mortem* examination, and of two guineas if he has performed such examination. Medical practitioners are also liable to a penalty of 5*l.* if they neglect to attend.

The act 1 Vict. c. 68, authorises the justices of the peace in England and Wales, at their quarter-sessions, and the town councils of every borough which has a coroner's court, at their quarterly meetings, to make a schedule of the fees, allowances, and disbursements which the coroner is allowed to pay (except the fees payable to medical witnesses, under 6 & 7 Will. IV. c. 89), on holding any inquest. This schedule regulates for each county or division of a county the expenses to be paid to the constable for summoning witnesses, &c. There is usually a small sum allowed to each juryman, generally 1*s.* 6*d.* in counties and 1*s.* in boroughs.

The coroner has also occasionally to exercise a ministerial office, where the sheriff is incapable of acting. Thus where an exception is taken to the sheriff on the ground of partiality or interest, the king's writs are directed to the coroners. This incident to the office of coroners points distinctly to their ancient character as ministerial officers of the crown. When acting for the sheriff the coroner is, by the 7 & 8 Vict., entitled to the same fees as the sheriff.

By the Municipal Reform Act, 5 & 6 Will. IV. c. 76, § 62, the council of every borough, to which a separate court of quarter sessions has been granted, is empowered to appoint a fit person, not being an alderman or councillor, to be coroner of the borough, who is to hold his office during good behaviour. The fees and general duties of borough coroners are the same as those of county coroners; but the former are required by the statute to make an annual return to the secretary of state of all inquests of death taken by them. [DEODAND.] (See Hawkins's 'Pleas of the Crown,' book ii. cap. 9; Burn's 'Justice,' tit. 'Coroner;' and Jervis's 'Practical Treatise on the Office and Duties of Coroners.')

CORONET, an inferior kind of crown worn by the nobility. Of coronets worn by foreign nobility much may be seen in Selden's 'Titles of Honour,' and in Montfaucon; see also Gough's 'Sepulchral Monuments,' vol. i. pp. 133, 134. No coronets belonging to peers can be found in England earlier than the time of Henry III. The coronet seems at first to have been the distinctive mark of an earl. William de Valence, earl of Pembroke, who died in 1304, and is buried in Westminster Abbey, has only a plain fillet. Aymer de Valence, however, acknowledged by his treasurer the receipt of a coronet at his creation of earl in 1319. (See Gough, 'Sep. Mon.,' i. p. 86, from Selden's 'Tit. of Hon.') John of Eltham, second son of Edward III., who died in 1334, and is also buried in Westminster Abbey, has a coronet on which are leaves; it is the most ancient of the sort we meet with. Edward the Black Prince, who is buried at Canterbury, has his helmet adorned with a coronet of oak-leaves, formerly enriched with paste, or false stones, of which the collets only remain. (Ibid. i. 136.)

Of the coronets of the British nobility, as at present worn, all surround caps of crimson velvet turned up with ermine. That of a duke is a circle of gold, richly chased, having on the edge eight strawberry leaves of equal height: that of a marquess, a circle set round with four strawberry leaves and as many pearls on pyramidal points of equal height alternately: the earl's coronet has eight pyramidal points (five only being seen at a time), with as many pearls on the tops, placed alternately with as many strawberry leaves, lower than the pearls. The viscount has only pearls, without any limited number, placed on the circle itself all round. A baron has only six pearls set at equal distances. Viscounts and barons had no coronets allowed them till after Queen Elizabeth's reign; the former had them granted by king James I., the latter by a grant from Charles II. in the thirteenth year of his reign. In Sir Symonds D'Ewes's letter, giving an account of the coronation of king Charles I., it is expressly said that when the higher order of the peerage put on their coronets, the barons sat bare.

The coronet of the kings of arms is a plain circle of gold, bearing sixteen leaves, eight of which are higher than the others: and on the band, the motto "Miserere mei, Deus."

CORPORAL (in the French service *caporal*), a non-commissioned officer in a battalion of infantry. The word is derived from the Italian *capo*, signifying a head; and the title denotes that the person who bore it was the chief of a small squadron or party. During the reigns of Mary and Elizabeth, the corporal was a kind of brigade-major; he superintended the marches of the companies, and commanded the troops who were sent out on skirmishing parties. But at present he is immediately under the serjeant; he commands small guards, and places and relieves the sentries. He falls into the ranks and does the same duty as a private soldier, but his pay is rather higher.

Lance-corporal, originally *lance-spesata*, denoting a broken or spent lance, was a term applied to a cavalry soldier who had broken his lance or lost his horse in action, and was subsequently retained as a volunteer in the infantry till he could be remounted. He is now merely a soldier who does the duty of a corporal, but without the pay, previously to obtaining the full appointment to that grade.

The rank of corporal is indicated by two stripes on the arm, that of lance-corporal by only one.

CORPORATION. In the progress of European society the want was early felt, of some means by which a permanent existence might be given to undertakings, arts and crafts, to religious doctrines, systems, or mysteries; to sanitary or other eleemosynary foundations, and other matters of permanent interest and importance to each succeeding generation of men. Thus, if a trade or handicraft had reached to excellence, it became desirable to provide for keeping together its professors, for the conservation of its secrets, and for imparting them to a chosen few, who should in their turn perform the same duty to others, thus, as it were, perpetually keeping the lamp trimmed and burning. In this mode arose the idea of incorporation, or of establishing a fictitious person—an invisible entity—which should have powers of holding property, and of doing various acts like a human being, but having besides a perpetual duration and identity. Another instance may be stated: if it was desired to perpetuate a system of augury or divination, intended to aid in the government of future generations, the idea of incorporation was resorted to; in other words, a body of persons was constituted with powers and under obligations to provide in certain appointed ways and modes for the maintenance of the body, by the election of a new member whenever a vacancy in the existing members should occur, constituted also, with certain fixed rules, as that the concerns of the body should be determined by the majority of voices; and this being done, property was vested in the abstract person or continuous entity, from the proceeds of which the expenses of the collective body were provided for. By this invention there was always in being a holder of the property; always a succession of members to manage and apply it. The subtle idea of, in this way, combining, in a metaphysical creation, the legal characters of the finite being with the essentials of infinity, is undoubtedly attributable to the Romans of the period which is usually assigned to the reign of Numa Pompilius. As society developed, the idea of establishing a continuous identity was applied to a variety of purposes: it furnished municipalities with a form of government which never wore out; charitable foundations and trusts were secured to the use and benefit of the objects of them, as long as such objects should continue to be found; education was provided for, and learning and religion kept alive through times through which perhaps no other means would have sufficed to carry them. It has been, however, in the shape of municipal incorporation that the idea has perhaps worked most conspicuously for the benefit of mankind as regards times past; the municipalities having no doubt been of the greatest service in preserving liberty, in cherishing trade and manufactures, and diffusing generally a spirit of liberty, self-reliance, and improvement among the people of Europe in the early and middle ages of modern times. That the Roman municipal system was never quite extinct in Europe is the opinion of the most distinguished scholars, jurists, and historians—Niebuhr, Savigny, Raynouard, Palgrave, Hallam, and various Italian authorities. In this country it is probable that the various municipal and other corporations, which are said in law to be corporations by prescription—that is having an origin some time before the reign of Richard I.—are traceable to the times of the Romans: thus London, York, Colchester, and many other cities and towns known to have been places of Roman residence, have ever been considered to have been incorporated at some very early period; and the same is the case of the stallingers of Sunderland, the dredgers of Whitstable, the free fishermen of Faversham, &c. (For Corporations among the Romans, see Heineccius, 'De Collegiis et Corporibus Opificum,' Opera, tom. ii., p. 366; the Italians 'Historiæ Patriæ Monumenta,' Turin 1836; and 'Muratori Antiquit.' iv. pp. 5, 159; German and Spanish Corporations, Robertson's Works, vol. iii., pp. 227-229; French, Raynouard, de Tocqueville 'France before Revolution of 1789,' p. 76, and 428 n.; English, Merewether and Stephens 'History,' 3 vols.; Hallam, 'Supplementary Notes to History of Middle Ages.') Some Piedmontese charters of incorporation date as far back as A.D. 707; and these are believed to be the oldest authentic charters in existence.

A charter, proceeding from the sovereign, was for long, the only known mode of creating a corporate body either in this or any other country of Europe. This consisted of a letter or rescript of the sovereign sealed with his royal seal, in which he called into a corporate existence the person or entity whom it was intended to establish, endowed it with a right, and fixed upon it the obligation of keeping up a perpetual succession of the members, gave it a name in which it was to sue and be sued, to hold land and other property, and to do all other acts, &c. It was also enabled to have a common seal, to be the emblem of its will; its concerns being in general managed by the voice of the majority of its members, who in all things bound the minority, and who signified the resolutions of the corporation, authenticated its contracts, &c., executed its deeds, &c., by affixing thereto the common seal. In this country the mode of incorporation by charter is at present but seldom resorted to, having been nearly superseded by the more modern device—dating only from the Revolution—of an act of parliament for each case, containing such regulations, imposing such restrictions, and giving such powers, as it is competent to parliament to appoint. Such is the nature and constitution of corporations, bodies politic, bodies corporate (as they are indifferently called), consisting of many members, or "aggregate of many," in the technical language of the law.

There is besides this another class of corporations called corporations sole, to which belong the king or queen regnant in his or her public capacity, every archbishop or bishop, every parson of a parish, &c.; but by much the more important class, at the present day, is the former, and to that therefore we shall chiefly direct our reader's attention in the remaining part of this article.

Corporations aggregate may be treated under the heads of Corporations in general (which would include ecclesiastical, sanitary, eleemosynary, educational, and other corporate bodies); municipal corporations; trading corporations. (See Kerr's Blackst. 'Comment.,' vol. i. cap. xviii.) The life and functions of *every* corporation aggregate are the creation of its charter or constituting statute (as the case may be); they do not exist for any other than the purpose therein specified; for any other purpose the members are merely an unorganised number of persons, not bound by the numerical majority, not a body, not a partnership, wholly unrecognised as endowed with aggregate capacity or collective powers. Hence it is idle to contend, as is sometimes done, that the acts and deeds of corporations are to be received and treated like the acts of natural persons or individuals; for corporations are artificial persons, and there is an essential difference between their acts and those of individuals. An individual may do what he likes with his own; he may bind himself by deed disposing of his property, however capriciously, without equivalent passing to him, without the law of England investing the courts with any power of interference, provided no fraud has been practised on him. But a corporation is fettered in its volition by the terms of its constitution: to them its course must be conformed. Any act done, or agreed to be done, either in violation of those terms or for purposes not comprised within those terms fairly construed, is illegal at law and will be restrained in equity,—such illegality forming a defence at law for the corporation when sued for the non-performance of its undertaking to do the act, or the ground of an injunction in equity to prevent the corporation from applying its funds for the purposes so unauthorised or prohibited.

Among the powers and capacities which are common to all corporations aggregate, are, those of having a corporate name; of suing and being sued in that name; of having a common seal, and doing all acts, executing all contracts, deeds, grants, orders, notices, and generally all formal documents by and under that common seal; to take goods as long as that body endures, and as incident thereto to lease, mortgage, and charge the same; to make and establish what are called "bye laws" (in the language of the law), being regulations for the management of the concerns of the corporation, the government of its members, and in many cases of persons other than its members, who may come within its sphere of action [BY-LAW]: these, when once duly passed, can only be abrogated by a counter vote of a majority of the body duly assembled, or by a judgment of a court of justice overturning them as being contrary to some principle of the general law of England. All the acts of the body are determined by the vote of the majority of the members duly in corporate meeting assembled.

Whilst the majority is acting for the objects and within the scope of the constitution of the body, they are never liable at common law, in their own persons, for the consequences of what they determine to do as a corporation; such act is the act of the corporation, and if any one is aggrieved by that act, the corporation is the proper person to be sued, not the aggregate or the majority, or any other part of the members; and if judgment goes against the corporation it pays the damages or the penalty out of its corporate funds. If, however, the majority take upon them to use the corporation powers and apply its funds to other purposes than those for which the body politic was called into existence, there are various cases in which the individual members of the majority may be made liable to answer, with their own property, the injury that their conduct may have done to others, whether strangers or members of the same body. There are means also by which projected applications of the powers and funds of the corporation, to purposes and objects for which the body was not constituted, and the funds were not devoted, will be prevented in the courts of equity.

As a corporate body is thus incapable of doing anything which is beyond the objects for which it was established (for it has not been given a perpetual existence and endowed with powers except for the accomplishment of the particular ends for which it was created), to do anything not comprised in them is *ultra vires*, and the attempt to effect it is void. So, as a matter of course, the body cannot put a period, by any act of its own simply, to its own corporate existence; although, in cases where the corporation has been established by a charter, the majority, with the consent of the crown, may resign or surrender the charter, which being accepted, the corporation is extinct. A corporation may also pass out of existence by reason of all the members dying out, care not having been taken to keep up the number of the members, by fresh elections, as vacancies occurred. Or a corporation may be dissolved or abolished by statute, though this has only been done, against the will of the bodies concerned, in the case of the Knights Templars, and of the convents and priories in the reign of Henry VIII. But the crown cannot, of its own will, abolish a corporation.

Corporations for ecclesiastical, eleemosynary, and educational purposes differ chiefly from municipal and trading corporations in this,—that they have appointed to them by the terms of their foundations *visitors*, whose duty and right it is to see that these bodies perform the duties with which their institutions are charged, and who, for that purpose, are armed with unique summary powers, for from their decisions there is no appeal. It is to this class of corporations chiefly (though not exclusively) that the statutes of Mortmain apply, restraining corporations from holding land without a licence from the crown, and the statutes of Charitable Uses, preventing corporations from holding land devised or granted to them for charitable purposes, except the grantor, &c., have first complied with certain requirements. [MORTMAIN.]

Municipal corporations are those by and under which the cities, and nearly all the principal towns, of this country are governed. Having originated, some by prescription and others by charter, and having therefore constitutions originally of very great variety, as well as a number of customs prevalent within them, chiefly in restraint of trade, they were all reduced to a common model by a statute of William IV., which, with some additions and modifications from subsequent statutes, has remained the governing statute since 1835. All the above-mentioned customs of trading were at the same time abolished, the statute applying to the municipal corporations of England and Wales except that of London, the customs of which have repeatedly been confirmed by parliament; and as yet (1859) London is left nearly untouched by municipal reform.

Trading Corporations.—A partnership is a company of persons associated together for the purpose of making profits by trade, each of the partners being entitled to such a share of the net profits, at the end of the year, as may be agreed upon and settled by the deed or other instrument, or by the terms of the partnership, and each bearing losses, where any occur, and being liable to the whole extent of his fortune. A trading corporation, however, is an incorporated association, having a joint or common stock of money, mostly divided into equal shares, the possession (by purchase for the most part) of one or more of which constitutes membership: the business is conducted for the common profits, the net returns of it being thrown into a common fund, out of which a rateable proportion is divided periodically, according to his number of shares, to each member, such proportion being called the dividend. Thus, then, the business is worked, in the legal sense, by the corporation, for its profits in the first instance; all outgoings are paid and all contracts made by the corporation, which is responsible, in its common stock, for all claims, whether in the nature of debts, or for compensation in damages for negligence or misfeasance, and the dividends are made out of the surplus remaining of the profit fund after defraying these and all other charges. In these bodies, like as in other corporations, no member has any individual right to any portion of the property, real or personal, of the company except so far as a declaration of dividend entitles him to his proper portion of the profits, on any periodical division; but unlike what takes place in common law corporations, the members of joint stock trading corporations, are, by statute, liable personally to the debts of the corporation after the common fund has been exhausted, and even those who are no longer members, may, in certain cases, remain liable for a period of three years after they have ceased to hold shares. Most classes of trading corporations may be dissolved by virtue of statutory enactments, applying to those classes, by means of what is called "winding up," under which system an account is taken of their debts, liabilities, and assets, and if necessary the members are called upon to contribute rateably, according to their shares, such sums as in the aggregate suffice to balance the accounts of the company. (See Kerr's Blackstone's 'Comm.' vol i. chap. 18.) The modern trading corporations bear little or no resemblance to the incorporated trades or guilds of the middle ages, which were associations for the teaching and managing, each of its particular handicraft, and for eleemosynary purposes, in regard to its members, who might fall into decay. They were not established with any view to traffic or the making of profits.

For incorporated companies trading as bankers, see Grant on 'Banking'; and the article BANK, BANKER, BANKING.

For general information on corporations, see Grant's 'Law of Corporations,' where particulars are stated of the law respecting the universities and their colleges; grammar schools; hospitals; dean and chapters; guardians of the poor; bishops, parsons; and generally respecting all descriptions of corporate bodies known in this country.

CORPORATIONS (MUNICIPAL) OF IRELAND. The present constitution of the boroughs of Ireland, will be treated under MUNICIPAL CORPORATIONS. The following is merely a historical notice of some of the peculiarities no longer existing, which marked the Irish corporations.

The whole system of boroughs, which holds so conspicuous and important a place in the history of the political and general civilisation of the British islands, is, in nature as well as name, of purely Teutonic original: that particular species of organisation having ever been found repugnant to the habits and spirit of the Celtic nations in their independent state. Thus, in Great Britain itself, its local limits advanced with the growth and extension of the Germanic colonies both north and south of the Tweed; and in Ireland we find that the native race were strangers to it until the settlement on their eastern and southern coasts, about the 9th century, of some of those Danish, North-man, or, as they were called in Ireland, Ost-man (East-man) bands, in that great æra of the permanent migrations of those formidable sea-rovers. Of these maritime settlements, five, namely, Dublin, Wexford, Waterford, Cork, and Limerick, appear as places of note at the commencement of the Anglo-Norman conquests in the island, and as possessing that municipal organisation which constantly attended all the branches of the Teutonic race. The Ost-man colonists of Ireland, too, though for a considerable time after their first settlement they adhered to their ancient paganism, had at the period in question, owing undoubtedly to the amicable relations which had arisen between them and the Irish population, and to the exertions of the Irish clergy, been long in the profession of Christianity; so that, it should seem, the first Anglo-Norman invaders might have recognised in them some degree of national affinity. But being ignorant and brutal, though subtle and daring adventurers, their thirst for plunder and for territorial acquisition would not permit them, in their career of murderous rapine, to make any distinction in treatment between the Scandinavian and the Celtic blood, between the Ost-man and the Irishman.

This unsparing temper of the early private invaders perfectly coincided with the policy of the English crown; and so soon as Henry II. had found leisure to take the business of the invasion into his own hands, one of his principal measures for securing the footing of his government on the Irish soil was the colonisation of the Ost-man ports with English or Anglo-Norman settlers. Thus the Ost-men of Dublin were thrust without the walls of their city to inhabit the suburbs thence called Ost-man town, and still, by corruption, Oxmantown, giving place to a band of mercantile settlers from Bristol, who became the English king's "burgesses" of Dublin, with a charter of liberties modelled exactly upon that of Bristol. In like manner, during the various fluctuations of the territorial conquest, down to its completion at the close of the reign of Elizabeth, every permanent extension of the English frontier extended the English organisation of the territory, of which the establishment of fortified towns, with inhabitants municipally organised and trained to arms, was a constant and a prominent feature.

The municipal commissioners of 1833 could not help observing the "marked distinction in the language of their charters, as to the constitutions of the municipal corporations in Ireland, according to the dates of those instruments," that is, according as they were granted before or after the commencement of the reign of James I. This was precisely the period when the crown was most actively exerting itself to secure the power of moulding the borough constitutions at its pleasure; and in the middle of James's reign was given the notable judicial decision in favour of the prerogative of establishing close boroughs by charter, upon which the crown ever afterwards acted. Far, however, as the exercise of this power was carried in England, yet, in the hands of the Stuarts at least, it failed of the complete attainment of its object. But in Ireland, which presented a much clearer field for its exertion, it was used both lavishly and effectually, not only in establishing new boroughs, but in reframing the constitutions of the old ones. In the "plantation of Ulster," as the settling of British inhabitants upon the lately-forfeited lands there was then denominated, by charters granted by James to various "undertakers" of the plantation, a number of incorporations were made beforehand, on the new and approved plan of towns "to be built" on the respective lands. Another and very similar mode of making boroughs in Ireland at this period was the incorporating of some village already existing, at the same time placing its corporation under the absolute control of the lord of the manor existing previously or newly erected. The whole number of boroughs thus created by James I. and his two immediate successors, a large proportion of which were originally of the class just described, though some of them have since risen to importance, was 61, and the number of the older boroughs was 45; there were also 11 other places which sent representatives to the Irish parliament, though no charters were in existence, but which derived their right from usage.

Each of the 106 corporations referred to above, sent two members to the Irish House of Commons, and many of those created by James I. and his two successors served scarcely any other purpose from the beginning, their incorporation having been little more than a cover for the nomination of the two members by the landed proprietor. Many had consequently fallen into virtual disuse long before the legislative union with England.

The mode of incorporation adopted by the crown in erecting the modern boroughs, presents little more than a parallel to the course it was pursuing in England; but in order to explain how it was that the subversion which it effected in the *ancient* borough constitutions of Ireland was so much more rapid and more complete than in those of England, we must advert to some very remarkable features in the politico-religious history of Ireland.

In the very first establishment of boroughs in that country, the Anglo-Norman crown had found itself under an absolute necessity of placing the municipalities on the footing of the most favoured class of boroughs in England: the security of the English power upon the Irish soil required that the incorporated burgesses should be strong and prompt for defensive warfare; and, to be so, it was essential that they should be free. Not only therefore were the municipal and the parliamentary franchise enjoyed by the inhabitant householders at large, but their common exemption from burdensome duties and services, and from feudal jurisdictions, was rendered more effective than in England itself: and such, on the whole, did the civil condition of the Anglo-Irish boroughs continue to be until the completion of the territorial conquest. This completion, while it relieved the ancient boroughs from the danger of external attack from the unsubdued native Irish population, rendered their internal freedom more liable to attack from the English crown, at length relieved from the risk and embarrassment of the old contest with "the Irish enemy." Another remarkable circumstance appeared just at the same period, which, while it commenced an entirely new era in Anglo-Irish history, placed in the hands of the English government a weapon of sweeping efficiency for the prosecution in Ireland of its new policy towards ancient boroughs in general. When Henry VIII. had abolished, to his own advantage, the papal supremacy in England, the new religious reformation obtained only a partial reception in Ireland. In the reign of Elizabeth two statutes were passed relating to the crown's religious supremacy and to the uniformity of common prayer; but her government was too discreet to enforce either of them, except as to the clergy and the leading officers acting in civil capacities under the government. But James I. sent presidents or military governors through the Irish provinces for the immediate enforcement of the statutes in question, especially in the corporate towns. The leading municipal officers were ejected, others, of known pliancy, were substituted in their places; and these persons readily resigned the rights and liberties of their towns into the king's hands, and took out new charters of incorporation. And here it was that the leading object of the crown was accomplished. To the several ancient boroughs new charters were soon issued, so framed as to leave but a very small share of municipal power to the great body of the inhabitants. In these charters individuals were expressly nominated to fill the offices of mayor, sheriff, recorder, &c.: the members of the governing council of the corporations were in most instances nominated in like manner, with exclusive power to appoint their successors; so that the inhabitants at large were almost wholly deprived of that share in their local government which, under the original constitutions of these boroughs, they had enjoyed for upwards of four centuries.

The system of exclusion was closely pursued by the persons thus newly placed in corporate authority, who, by this means, gradually severed their interests from those of the inhabitants at large: still they were unable wholly to extinguish the municipal rights of the ancient class of freemen, who though excluded by test-oaths from the higher corporate offices, continued pretty numerous until the year 1654, when the army of the Commonwealth obtained possession of all such towns. No sooner was Charles II. restored than the Lords Justices of Ireland issued a proclamation confirming to every one holding by grant or contract with "the late usurped powers," all their lands and possessions, as well in towns as elsewhere, during a given period. Under the authority of this proclamation, when the Irish legislature was called together for the general arrangement of landed property, and other public interests, which had been completely subverted by so many years of civil war, the Commonwealth soldiery, who, under Cromwell, had possessed themselves of the walled towns, were able to return an overwhelming majority of members to that parliament which passed the Acts of Settlement and Explanation. The permanence of their interest was thus provided for; and the estates, rights, and liberties of those corporate establishments were vested in a body of men but recently settled in the kingdom. The unjust exclusion consequently maintained, became, in the course of the same reign, a subject of inquiry with the Irish government; but, wavering as that government has so often been between justice and expediency, it procured no effectual change in that system, the evils of which it seemed to deplore.

One measure, however, was taken at this period, the tendency of which was to mitigate in some degree the spirit of absolute exclusion prevailing in the Irish municipalities. The Act of Explanation empowered the Lord Lieutenant and Council, within seven years, to make rules, orders, and directions, for the better regulation of all cities, walled towns, and corporations. By virtue of this power, the Lord Lieutenant and Council, in 1672, issued what are called the "New Rules," which ordained that thenceforward the elections of persons to serve the offices of mayor, sheriff, recorder, or town-clerk of Dublin, Limerick, Galway, and the several other towns therein mentioned, should be subject to the approbation of the Lord Lieutenant and Council; and that no person should be capable of acting as mayor, recorder, sheriff, treasurer, alderman, town-clerk, common-councilman, or master or warden, until he should have taken the oath of supremacy, except such only with whose taking that oath the Lord Lieutenant should think fit, by name and in writing, to dispense. But that part of these New Rules which tended to restore the ancient basis of the municipal franchise, was a provision that all "foreigners, strangers, and aliens, being merchants, or skilled in any mystery, craft, or trade," then or thereafter residing and inhabiting within those cities or towns, should, on paying down a fine to the mayor and common council, or other persons authorised to admit freemen, be admitted to the freedom of such city or town respectively, and if they desired it, into any guild, brotherhood, &c., therein; that any person refusing to admit them so applying for their freedom should, upon due proof before the Lord Lieutenant and Council, be for ever deprived of the freedom of such city or town; and further, that on such refusal of admission by the corporate authorities, such person so applying should, on tendering twenty shillings, and taking the oath of allegiance before any justice of peace in the adjoining county, be therefore deemed, to all intents and purposes, a freeman of such corporation, guild, &c. Thus, in spite of the exclusive system then in operation, every resident trader in the corporate towns of Ireland was enabled, under these rules and orders, to become a freeman; though still, except by special dispensation, he could not fill the higher municipal offices, unless by taking the oath of supremacy and giving the other tests then required.

But after the Revolution of 1688, the spirit and intention of this portion of these rules were wholly disregarded. Owing, indeed, in some degree to James II.'s unsuccessful attempts against his opponents in the corporate towns of Ireland, the system of absolute exclusion pursued in the early part of his brother's reign was revived with aggravated rigour; and under such circumstances little was to be expected from seeking the benefit of the rules and orders, or bringing in any other mode the rights of the excluded before such tribunals as then existed. From these causes, and from a sort of inviolability or sacredness of character which was thrown about corporate establishments in Ireland from the reign of William III. to the passing of the Irish Municipal Corporations Act in 1840, by which a number of them were disincorporated, and the remainder, in their constitution, were assimilated to the English boroughs as regulated by the Municipal Corporations Act, England (1 Vict. c. 78, 1837), by which all religious distinctions as affecting the rights of the inhabitants were wholly abolished, the inhabitants at large of municipal towns remained wholly unconnected in interests or feelings with the few individuals monopolising all corporate authority.

CORPULENCE. [OBESITY.]

CORPUS JURIS CIVILIS. The term corpus juris (literally a body of law) which so far back as the year 1262, was specially applied to the several compilations made by Justinian (Sarti 'de Claris Archigymn,' t. i. pt. ii. p. 214), was not then used for the first time, for Livy (iii. 34), in narrating the history of the introduction of the decemviral code, and the reception it met with at Rome, states that the common impression was that two more laws were wanted to complete the work, for if they were added "absolvi posse velut corpus omnis Romani juris," whilst Justinian himself uses the term in the sense of the collection of Roman law then in being (C. 5. 13 pr.) But there are now two principal collections to which that appellation is given, the Corpus Juris Civilis and the Corpus Juris Canonici. [CANON LAW.] The term Corpus Juris Civilis designates the book in which the different parts of the legislation of the Emperor Justinian are collected, and which, considered as one whole, contains the main body of the Civil or Roman law. According to this definition, the Corpus Juris Civilis consists of the compilations of the codex, pandects or digests, institutes, and novels, which were made under the direction of the emperor Justinian.

Justinian himself, regarding each part of his legislation as a separate collection only made for the purpose of completing former compilations, never thought of giving a common title to them all. Each part had its separate and appropriate name; for instance, the codex was so called because it was the book in which the Roman emperors' constitutions were collected; the institutes were so called because they contained the first principles and rules of the law; the digest or pandects because they were the collection of the digested decisions and opinions of the old lawyers, forming a common receptacle of legal learning (C. I. 17, 3, 1); and the novels because they were new constitutions (novellæ constitutiones), published by imperial authority after the appearance of the former works, namely, between the years A.D. 535 and 559. In the middle ages, when the study of the Roman law began to flourish in the universities of Italy, the jurists were led to consider Justinian's separate collections as one entire legislation, to which a general title would be appropriate. Savigny, in his history of the Roman law in the middle ages, asserts that the term Corpus Juris Civilis was used in the 12th century. However, Russardus, professor in Bourges (which, in the 16th century, was one of the most celebrated French universities for jurisprudence), who first edited the collections of Justinian under a common title, at Lyon, in the year 1561, chose only the term Jus Civile for that purpose; and Dionysius Gothofredus, likewise a French jurist of Paris, is commonly considered as the first who, in his edition in the year 1583, at Lyon, adopted the term Corpus Juris Civilis as a general title for the collections of Justinian, for before this time each of the three volumes into which the glossers divided the collection, was known by a particular title; the first volume being called 'Digestum Vetus,' comprising the first twenty-three books and the first two titles of the twenty-fourth book; the second volume, 'Infortiatum,' running from the third title of the twenty-fourth book to the eighty-second paragraph of the second title of the thirty-fifth book; and the third volume 'Digestum Novum,' containing the remainder of the work. (See in 'Heynii Opuscula Academica,' vol. ii. p. 315, some remarks on this division.) From the time of Gothofredus his title has always been in use.

The Corpus Juris Civilis, as it is now composed, contains: 1. The Collections of the Emperor Justinian, namely, the Institutes, in 4 books; the Pandects or Digests, in 50 books; the Codex, in 12 books, together with the Authenticæ, a name given, not by Justinian, but by the Glossers (professors of law, who in the 12th and 13th centuries taught the Roman law and explained the text of the Corpus Juris in the universities of Italy, especially Bologna) in order to distinguish the collection made by them and appended to the Corpus Juris from the Epitome Novellarum made by Julianus, A.D. 570; the number of these Novellæ Constitutiones is 168. 2. An arbitrary appendix, joined to the Corpus Juris by different editors since the time of Russardus, namely, *a*. several Constitutions of the Emperor Justinian and his two successors Justinian II. and Tiberius II., called Justinian's 13 edicts, which were first received into the Corpus Juris by Russardus; *b*. several other Constitutions of the same three emperors, which were first added by Contius, in his edition of 1571; *c*. 113 Constitutions of the Emperor Leo, the philosopher, given by him for the purpose of amending and correcting Justinian's legislation, together with a Constitution of the Emperor Zeno, likewise first added by Contius in his edition; *d*. a series of Constitutions of the successors of the Emperor Justinian from the 7th to the 14th century, first added to the Corpus Juris in the edition of Charondas of 1575; *e*. a series of 84 (or 85 according to the older division) ecclesiastical Canons, called Canones Sanctorum et Venerandorum Apostolorum, first added to the Corpus Juris by Gregorius Haloander about A.D. 530. According to the descriptive title by which they are headed they are to be ascribed to Clement, the first bishop of Rome, but their origin and history are involved in so much doubt that many writers have not hesitated to pronounce them to be apocryphal and devoid of authority (Dupin, 'Bibliothéque Ecclesiastique,' t. 1, p. 135); probably they are a private collection of decrees of councils and synods existing prior to the synod of Nicæa, A.D. 325; *f*. the Libri Feudorum, that is, the books which contain the usages and customs of the feudal system, and which were joined to the Corpus Juris by the Glossers; *g*. several Constitutions of the Emperor Frederic II.; *h*. a short book in ten titles, called 'Extravagantes, or Undecima Collatio,' containing some Constitutions of the Emperor Henry VII., A.D. 1312; *i*, and last of all, the Liber de pace Constantiæ, or the Treaty drawn up, A.D. 1190, between Frederick I. and the Lombard States, by which the freedom of twenty-four Lombard cities was granted. In several editions we find other appendages besides those here noticed.

The manuscripts of the Corpus Juris Civilis are numerous, but nearly all of them contain only a part of Justinian's legislation: manuscripts containing the whole body of law are very rare. The best MS. of the latter is at Copenhagen. Of MSS. before the time of the Glossers we have only one of the Pandects, the celebrated Florentine manuscript, which was first at Pisa, but was brought to Florence in 1411, after the capture of Pisa, A.D. 1406; it probably belongs to the 6th or 7th century, and some even suppose that it may be the original copy of the Pandects which was sent by Justinian to the Western Empire. Whatever its early history may be, whether, as Odofredus says, it was brought to Pisa from Constantinople, or as the old story, constantly repeated and supported by Brencman among others, has it, that it was given to the Pisans by Lothario II., after the capture of Amalfi, A.D. 1133, its importance consists in the claim set up for it as being the sole authentic source from which the text of all other MSS. has been taken; a claim as earnestly opposed as it has been hotly contended for, and only to be settled, if it be possible, *tantas componere lites*, by the conjecture that there was another manuscript coeval with or prior to the Florentine text and accessible to the Glossators, and that each of these was copied from one and the same original. The other manuscripts are of the 12th 13th, and 14th centuries, and contain the *versio vulgata*, or text as settled by the Glossators according to older manuscripts. In Munich and Paris there are valuable manuscripts of the *versio vulgata* of the Codex. As to the manuscripts, see Beck, 'Indicis Codicum et Editionum Juris Justinianei Prodromus,' Lips. 1823. Of the manuscripts in England, there is a valuable notice in the 5th vol. of the 'German Magazine of Historical Jurisprudence.'

There are numerous editions of the 'Corpus Juris:' it was printed very soon after the invention of the art, but at first only separate parts were published. The oldest edition that we know of is that of the Institutes, by Peter Schœffer, in Mentz, of the year 1468. There is a copy of this edition on vellum in the King's Library, British Museum. It has a small illumination of a presumed portrait of Justinian in the title-page. The larger capital letters throughout the books are illuminated, and some of them with gold. The last edition of importance is that of Schrader (Berlin, 1832), who formed the design of preparing an accurate and trustworthy edition of the 'Corpus Juris Civilis.' Till the year 1476 all the parts of the 'Corpus' were printed separately. The first edition, which contained the whole, is that by Honate, at Milan, of the years 1482 and 1483, but still not under a general title, which, as already mentioned, was first used by Russardus. Till the year 1518 all the editions were printed with the glosses, but after that date the glosses were commonly omitted. The last edition with glosses is of the year 1627. For a complete list of the editions, see Beck's 'Index.' Probably there are no editions that have been so generally received and have met with such favour as those of the celebrated Denys Godefroi; of these, the first, a quarto, appeared in 1583; the second, 2 vols. folio (a revised copy of the first), in 1590; the third, 4 vols. folio, in 1602; and the fourth, 2 vols. folio, in 1607; all of them being published at Lyon. These were followed in the year 1624 by an edition more complete than any that had preceded it, published at Geneva by his son James. In 1663 Simon Van Leeuween produced a folio edition at Amsterdam, in which not only the notes of Godefroi were given, but those of several other distinguished commentators; and in the same year a copy of Godefroi's first edition was published at Frankfort. The book, though extremely scarce, has very little to recommend it to the student. J. L. G. Beck, in 1825, published a very useful and carefully edited copy of the 'Corpus Juris' in two quarto volumes.

CORPUSCULAR THEORY. [MOLECULAR THEORY.]

CORRECTION, HOUSES OF. [REFORMATORIES.]

CORRELATION OF PHYSICAL FORCES. [FORCE.]

CORRIDOR, from the Italian *coridore*, signifies a gallery or passage-way leading to apartments independent of each other. In all large buildings containing numerous apartments corridors are necessary, either closed or open. The corridor round the great cortile or open court of the Cancellaria at Rome, designed by Bramante, consists of an open gallery supported by columns.

CORROSIVE SUBLIMATE. [MERCURY, *Bichloride of.*]

CORRUGATION. A very simple but effective mode has been adopted during the last few years, of imparting additional strength to sheet metal. This consists merely in *corrugating* it; that is, bending it into a series of opposite curves, convex and concave alternately. The usual mode of producing this result is by passing the sheets between two rollers corrugated on their surfaces, rings of depression alternating with rings of protrusion, and the protuberances of one roller corresponding with, and working into, the depressions of another. If the two rollers work nearly in contact, a sheet of metal passed between them is forced to take a corrugated form; and if the rollers be powerful while the metal is thin, this might be done when cold; otherwise a heating of the metal is needed, especially when the corrugations are deep. Iron is the chief metal thus treated; though there is nothing to prevent the application of the process to copper and other metal. The iron may be galvanised or coated with a film of zinc, to render it more weather-proof; but this process is not necessarily connected with corrugation. The uses of corrugated iron are now very numerous, seeing that the material acquires, in practical construction, a degree of strength altogether beyond that which belongs to the mere thickness of the sheet. It will form either a wall or roof, with very little support from other sources. Railway travellers have become accustomed to the use of this material in the sides and coverings of ticket-platforms, in the sides of carriage sheds, and in the roofs and appendages of stations. In dockyards and other large establishments, it is much employed for light and temporary structures. Temporary churches are in part made of it. It is used also for emigrant houses and storerooms.

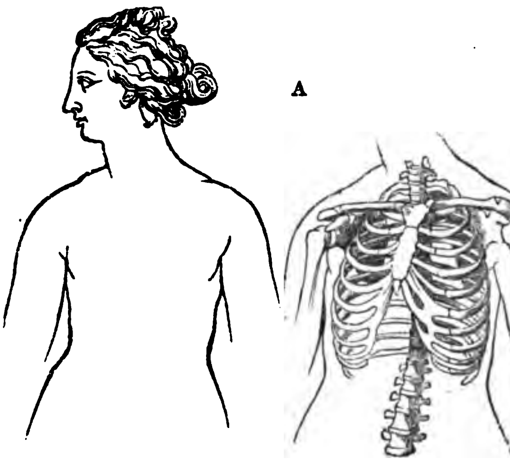
An American inventor, Mr. Joseph Francis, of New York, has devised a remarkable mode of applying corrugated sheet-iron to the construction of very light and buoyant boats, available as safety-boats, and for other purposes. Captain Portlock has described the difficulties attending this application, and the ingenious way in which those difficulties have been surmounted. By corrugating the iron, the flexible sheet is rendered rigid as the surface is bent, so as to produce longitudinally, in effect, a series of parallel girders or beams, and transversely a series of arches; but it is also evident that by thus rendering the sheet rigid, the difficulty of adjusting it to a curved or varying surface is greatly increased. Mr. Francis's mode of getting over this difficulty is a singular one. He produces the rigidity due to corrugation, and the form of the boat itself, by one simultaneous operation. For this purpose, he prepares pressing or stamping apparatus, in the form of enormous dies, and corresponding in shape and size with the boat to be made, with grooves to represent the corrugations. The plain sheets of iron being placed between the two dies, or the die and counterdie, and subjected to a powerful hydrostatic pressure, are at the same time shaped and corrugated. In the earlier experiments, however, he found that the same breadth of metal being required to be adjusted to different spaces, the surfaces became wrinkled, overlapping the lesser spaces. This obstacle he removed by adjusting the gauge of the corrugations to the position of the sheet; and thus, as it were, not only swallowing up the superfluous metal, but giving more strength to the parts requiring it. The theory of this construction is, that the combined curves and corrugations give so much strength to a boat of small size, as to render all internal bracings and strengthenings unnecessary. Major Vincent Eyre, in a paper read before the British Association for the Advancement of Science at the Cheltenham Meeting in 1856, gave an account of these corrugated boats which, if not too highly coloured, denotes the combination in them of many very remarkable qualities. Two trials of boats were made, one at Liverpool and the other at Woolwich, "On both occasions the tests were such as not even the strongest wooden boat that was ever built could have sustained without going immediately to pieces. For instance, being manned by a full crew, they were rowed several times with full speed against the stone-work of the dock; they were tossed over and over with excessive violence on the stone pavement; they were filled with large blocks of stone placed midships and piled up to a considerable height, and then hoisted up by tackle head and stern; they were battered on the sides by large hammers on one spot, with all the force a strong man could muster—but all without producing the slightest injurious effect. At the end of this rough treatment, they were found perfectly whole and watertight." This authority summed up his encomiums by declaring the corrugated boats to be fire-proof, water-proof, worm-proof, incorrodible, liable neither to warp nor to split: strong, light, buoyant, and cheap. Boats of this construction were used by Lieutenant Lynch, in the United States expedition to the Dead Sea and the river Jordan; they were impelled against rocks, dragged over shoals, swept down rapids and cascades, and exposed to other rough usage, which they bore well.

It has been suggested that corrugated iron, manufactured in this way, would render good service as a material for military waggons, which would either run upon wheels on land, or float on water, and thus serve as waggons, bridges, or boats.

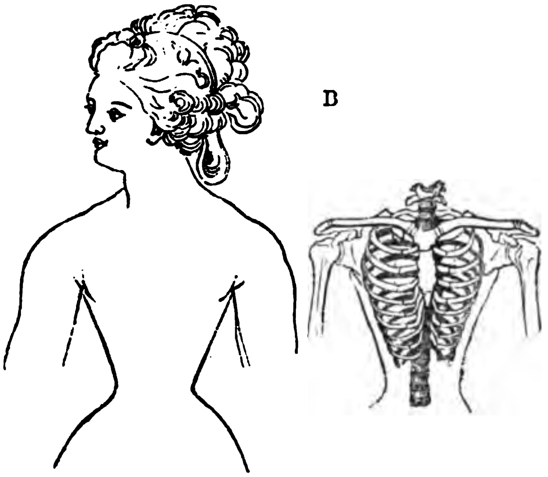
CORRUPTION OF BLOOD. [ATTAINDER.]

CORSET, an article of dress for compressing, under the pretext of supporting, the chest and waist, worn chiefly by females, but also sometimes by effeminate individuals of the other sex. It consists of cloth made to surround the body, stiffened by whalebone or other means, and tightened by a lace. It seems a remnant of the old practice of enveloping the whole frame in swaddling bands; a practice which has been generally discarded in rearing male children, but which still lingers as a part of the attire of female children, in defiance of nature, reason, and experience. The advantages arising from its use are trifling, if any; the disadvantages, manifold and serious. Nature has formed the chest (in which are lodged the lungs for respiration and the heart for circulation, two out of three of the vital functions) in the shape of a truncated cone, the base of which is capable of being alternately widened and contracted during inspiration and expiration. The wonderful and perfect mechanism for carrying on respiration cannot come into full play if any compression be applied to the lower part of the chest, which is however the part commonly selected, from yielding most easily, to endure the hurtful restraint of tight lacing. The chest never being allowed to expand to the extent which is necessary, the defect in each respiration is attempted to be compensated for by their greater frequency, and thus a hurried circulation is produced. The heart is also hindered in its action, and an imperfectly aërated blood is circulated by it, by which nutrition is inadequately accomplished: unhealthy secretions are likewise formed out of this vitiated blood, and prove a further source of disease. The muscles of the chest, spine, and abdomen, being deprived of their proper exercise, become attenuated and feeble, and incapable of giving due support, whence result distortions of the spine and chest, and much of that constipation which so frequently afflicts females. The viscera of the abdomen, especially the liver, suffer greatly, both by displacement—being forced downwards—and by being actually indented by the edges of the compressed ribs. "In examining," says Dr. Hodgkin, whose connection with Guy's Hospital gave him extensive opportunities of observation, "the bodies of the dead, I have frequently found the lower ribs of females greatly compressed and deformed. I have repeatedly seen the liver greatly misshapened by the unnatural pressure to which it had been subjected, and the diaphragm or midriff very much displaced." The diseases which result from this interference with nature are various; and though they do not all occur in every female who adopts this mischievous practice, yet on inquiry too many may be traced to this source. Of these diseases consumption is the most frequent and fatal. Nor is the real object of all this painful and irksome compression in any instance attained. The figure of the female bust may be altered by it, but not improved. Sculptors, who are the closest observers of nature, and who transfer to their statues every beauty presented to their eye, have invariably given ample dimensions to the lower part of the chest. The more therefore any female, not of unnatural proportions, compresses her waist, the more does she depart from resemblance to "the statue which enchants the world."

The accompanying figures, the first, A, representing the Venus de' Medici, and the skeleton in its natural form; the second, B, the form as altered by the use of tight stays, taken from Professor Soemmering, 'On the Effects of Stays,' will illustrate this.



A



B

CORTES, the name of the assembly of representatives of the Spanish nation. These assemblies have been variously constituted in different ages, and in the different kingdoms into which Spain was divided till the time of Ferdinand and Isabella. The cortes of Castile and Leon and those of Aragon were the principal. Considerable obscurity prevails as to the origin and the formation of both. The earliest national assemblies under the Visigothic kings met generally at Toledo: they consisted chiefly of the dignitaries of the church, and were called councils. After deciding all questions of church discipline, they concerned themselves with temporal affairs, and in this stage of the discussion the lay lords or barons took an active part, and the king presented his requests. In the acts of the council of Leon, A.D. 1020, ch. vi., the transition from ecclesiastical to temporal affairs is clearly pointed out: "Judicato ergo ecclsiæ judicio, adeptaque justitia, agatur causa regia, deinde populorum." In the acts of the council of Jaca, 1063, we find that several points of discipline were reformed "with the consent of the nobles and prelates;" and the signatures are those of the king, the infantes, nine bishops, three abbots, and three magnates; but it is added in a note that "all the other magnates had subscribed to the same acts." It is now generally acknowledged, that in that age, and down to the end of the 12th century, there was no popular representation from the towns or commons of Castile and Leon in those assemblies. (Marina, 'Teoria de las Cortes;' Sempere, 'Histoire des Cortes;' Prescott's 'History of Ferdinand and Isabella,' and 'Hist. of Philip II.') The people are said to have occasionally attended these national councils on some solemn occasions, as in the council held at Toledo in 1135, but only as spectators and witnesses, "to see, to hear, and to praise God." By degrees, as the towns rose into importance, and obtained local fueros, or charters, from the kings for their own security, or formed themselves into fraternities for their mutual protection against the Moors or against the violence of their own nobles, some of them obtained at last the privilege of sending deputies to the national councils, which were now styled cortes, because, according to some etymologists, they were held at the place where the king had his court. The cortes held at Salamanca by Ferdinand II., in 1178, consisted only of the nobility and clergy; but at the cortes of Leon, in 1188, we first hear that there were present deputies "of towns chosen by lot;" and in the same year the Cortes of Castile assembled at Burgos, where deputies from about fifty towns or villages, the names of which are mentioned, were present. How these places came to obtain this privilege is not known, although it is probable that it was by the king's writ or by charter. The cortes were henceforth composed of three estamentos or states, clergy, lords, and procuradores, or deputies from the enfranchised towns, forming together one chamber, but voting as separate states. It was a standing rule that general laws must have in their favour the majority of each estamento. This was the principle of the cortes of the united kingdom of Castile and Leon. The same principle existed in the kingdom of Aragon, only there the cortes were composed of four brazos or states,—namely, the prelates, including the commanders of the military orders; the ricos hombres, or barons; the infanzones, or caballeros, who held their estates of the great barons; and lastly, the universidades, or deputies of the royal towns. These last are first mentioned in the cortes of Monzon, in 1131. The towns and boroughs in Aragon which returned deputies were thirty-one; but the number of deputies returned by each is not defined by the historians, any more than those for the cortes of Castile. We find the same town returning sometimes a greater, sometimes a smaller number, and at other times none at all, and a small town or village sending more deputies than a large one; while many considerable towns never returned any, independently of the seignorial towns, which of course had no representative privilege. How all this was made to agree with the manner of voting, in order to ascertain the opinion of the majority, is not clearly stated.

In Castile, from the end of the 13th century, the popular estamento made rapid strides towards increasing its influence, being favoured in this by some kings or pretenders to the crown, such as Sancho IV. and Enrique II., or taking advantage of disputed successions and stormy minorities to obtain from one of the contending parties an extension of their privileges. In 1295 the deputies of thirty-two towns and boroughs of Castile and Leon assembled at Valladolid, and entered into a confederacy to defend their mutual rights against both the crown and the nobles. Among many other resolutions, one was, that each of the thirty-two constituencies should send two deputies every two years to meet about Pentecost at Leon or some other place, in order to enforce the observance of their stipulations. In 1314, during the frightful confusion which attended the minority of Alonso XI, we find another confederacy between the nobles and the procuradores of 100 communities, with a similar clause as to deputies meeting once or twice every year. These meetings of deputies for special purposes ought not to be confounded with the general cortes of the kingdom, which were always convoked by the king, though at no fixed times. Enrique II. having revolted against his brother, Pedro the Cruel, courted the support of the municipal towns, which at the cortes of 1367 demanded the admission *de jure* of twelve deputies into the royal council, which had till then consisted of hereditary nobles and prelates, with occasionally some civilians called in by the king. Enrique promised to comply with their request, but his brother's death having ensured his seat on the throne, he evaded the fulfilment of his promise by creating an Audiencia real, or high court of appeal, consisting of prelates and civilians, and a criminal court of eight alcaldes, chosen from different provinces of the kingdom. Juan I., who succeeded him after the loss of the battle of Aljubarrota, created a new council in 1385, consisting of four bishops, four nobles, and four citizens, with extensive executive powers. The towns next solicited the dismissal of the bishops and nobles from the council, in order that it should consist entirely of citizens; but Juan rejected the demand. "The 14th century seems to have been the brightest period of popular, or more properly municipal, representation in Spain. The cortes were frequent, and the subject of their deliberations of the most important nature. But Spain had never a definite representation; to no meeting of this period did all or half the great towns send deputies, and those which did return them appear to have observed little proportion in the numbers." (Dunham's 'Hist. of Spain and Portugal.')

The remonstrances or petitions of the general cortes to the king generally began as follows: "The prelates, lords, and caballeros of the kingdoms of Castile and Leon, in the name of the three estates of the kingdom," &c. Remonstrances from the deputies of the towns began: "Most high and powerful prince! your very humble vassals, subjects, and servants, the deputies of the towns and boroughs of your kingdoms, who are assembled in your presence by your order," &c. (Cortes of Valladolid, June, 1420.)

In the cortes of 1402, Enrique III. demanded for his wars with the Moors a supply of 60,000,000 of maravedis, but the deputies granted only 45,000,000. By his testament, Enrique excluded the citizens from the council of regency during the minority of his son, Juan II., and after this they were no longer admitted into the royal council. Thus the municipal towns lost a great advantage they had gained thirty years before under Juan I. They soon after sacrificed of their own accord their elective franchises. The expenses of the deputies to the cortes had been till then defrayed by the towns; but now, having lost their influence at court by their exclusion from the royal council, the towns began to complain of the burden. Juan II. listened attentively to their complaints, and, in the cortes of Ocaña, 1422, he proposed that the future expenses of the deputies should be defrayed out of the royal treasury, a proposal which was willingly accepted. Accordingly, in the next cortes, twelve cities only (Burgos, Toledo, Leon, Zamora, Seville, Cardova, Murcia, Jaen, Segovia, Avila, Salamanca, and Cuença) were summoned to send their deputation. Some other towns were informed that they might intrust their powers to any deputy from the above. The privilege was subsequently extended to six more cities—Valladolid, Toro, Soria, Madrid, Guadalaxara, and Granada. These eighteen places constituted henceforth the whole representation of the kingdoms of Castile, Leon, Galicia, and Andalusia. The other communities, at last perceiving the advantage they had lost, petitioned to be restored to their right, but found themselves strenuously opposed by the privileged towns. The influence of the court was openly exercised in the elections of these towns, and although the cortes of Valladolid in 1442, and those of Cordova in 1445, requested the king to abstain from such interference, yet the practice became more barefaced than ever. In 1457 Enrique IV. wrote to the municipal council of Seville, pointing out two individuals fit to be deputies in the next session, and requesting they might be elected. Thus long before Charles I. (the Emperor Charles V.), who has been generally accused of having destroyed the liberties of Spain, the popular branch of the representation was already reduced to a shadow; for the deputies of the eighteen cities elected by court influence, were mere registrars of the royal decrees, and ready voters of the supplies demanded of them. Under Ferdinand and Isabella the royal authority became more extended and firmly established by the subjection of the privileged orders. Charles only finished the work by excluding the privileged orders from the cortes altogether; he and his successors contenting themselves with convoking the deputies of the eighteen royal cities of the crown of Castile on certain solemn occasions, to register their decrees, to acknowledge the Prince of Asturias as heir apparent to the throne, to swear allegiance to a new sovereign, &c.

In Aragon, Valencia, and Catalonia, which formed the dominions of the crown of Aragon, the cortes of each of these three states continued to assemble under Charles I. and his successors of the Austrian dynasty, who convoked them in their accustomed manner by brazos or orders, and they maintained some show of independence, although in reality much reduced in importance, after Philip II. had abolished the office of the Justiza. [ARAGON, in GEOG. DIV.] But after the War of the Succession, Philip V. of Bourbon formally abolished the cortes of these states by right of conquest, as he expressed it, because they had taken part with his rival, the Archduke Charles.

When, in 1808, the Spanish people rose in every province against the invasion of Napoleon, the king was a prisoner in France, after having been obliged by threats to abdicate the crown, and the nation found itself without a government. Municipal juntas were formed in every province, consisting of deputies taken from the various orders or classes of society,—nobles, clergymen, proprietors, merchants, &c. These juntas sent deputies to form a central junta, with executive powers for the general affairs of the country; but a legislature was still wanting. The central junta was called upon to assemble the cortes for all Spain. They at first thought of reviving the ancient cortes by estamentos or brazos, but many difficulties presented themselves. The difference of formation between the old cortes of Aragon and those of Castile; the difficulty of applying those forms to the American possessions of Spain, which were now, for the first time, admitted to equal rights with the mother country, but where the same elements of society did not exist,—at least not in the same proportion; the difficulty even in Spain of collecting a legitimate representation of the various orders, while most of the provinces were occupied or overrun by French armies, and while many of the nobility and the higher clergy had acknowledged the intrusive king Joseph Bonaparte; all these, added to the altered state of public opinion, to the long discontinuance of the old cortes by orders or states, to the diminished influence of the old nobility, and the creation of a new nobility during the latter reigns merely through court favour, made the original plan appear impracticable. The situation of the country was, in fact, without a parallel in history. The central junta consulted the consejo (reunido), or commission of magistrates, from the old higher courts of the monarchy, who proposed to assemble deputies of the various brazos or estamentos, all to form one house,—a proposal extremely vague and apparently impracticable, which looks as if made to elude the question. Jovellados and others then proposed two houses, constituted as in England; but this would also have been a new creation without precedent in Spain, and surrounded by many difficulties, the state of society being very different in the two countries. Meantime the central junta being driven away by the French, first from Madrid, and afterwards from Seville, in January, 1810, took refuge at Cadiz, which became the capital of the Spanish patriots, whither a number of persons from the various provinces and classes had flocked. Soon after arriving at Cadiz it resigned its powers into the hands of a council of regency composed of five individuals, who issued letters of convocation for the deputies of all the provinces to assemble in cortes at the Isla de Leon on the 24th September, 1810.

The cortes, styled "extraordinary," sat at Cadiz from September, 1810, till September, 1813. During this time, amidst numerous enactments which they passed, they framed a totally new constitution for Spain, which has become known by the name of "the constitution of 1812," the year in which it was proclaimed. This constitution established the representative system with a single popular chamber, elected in a numerical proportion of one deputy for every 70,000 individuals. The extraordinary cortes of Cadiz were succeeded in October, 1813, by the ordinary cortes, elected according to the principle of the constitution. In March, 1814, King Ferdinand returned to Spain, and soon after dissolved the cortes, abrogated the constitution, and punished its supporters. In 1820 the constitution was proclaimed again through a military insurrection; the king accepted it, and the cortes assembled again. The king and the cortes, however, did not remain long in harmony. In 1823 a French army, under the duke of Angoulême, entered Spain; the cortes left Madrid, taking the king with them to Seville, and thence transferred him by force to Cadiz. Cadiz having surrendered to the French, the cortes were again dispersed, and the constitution was again abolished.

Ferdinand VII., before his death, assembled the deputies of the royal towns, according to the ancient form, not to deliberate, but to acknowledge as his successor his infant daughter Isabella. On April 10, 1834, the queen regent proclaimed a charter for the Spanish nation, which was called Estatuto Real. It established the convocation of the cortes and its division into two houses, the procuradores, or deputies from the provinces, and the proceres, or upper house, consisting of certain nobles, prelates, and also of citizens distinguished by their merit. The power of the cortes, however, was very limited, the initiative of all laws belonging exclusively to the crown. This charter did not last above two years. In the summer of 1836 insurrections broke out at Malaga and other places, where the constitution of 1812 was again proclaimed; and at last the insurrection spread among the troops which were doing duty at the queen's residence, at La Granja, in consequence of which the queen accepted the constitution, "subject to the revision of the cortes." The cortes were therefore convoked according to the plan of 1812; and early in 1837 they commenced their duties, forming a constitution which was decreed on June 16. By this the cortes were to consist of a senate and congress of deputies; each province was to return three persons as senators, of whom the sovereign was to select one: and there was to be one deputy for every 50,000 souls of the population. The deputies were to be elected for three years, and the cortes were to meet every year. Laws relating to taxes and public credit were to be first submitted to the deputies, and if altered in the senate were to be returned to the deputies for their ultimate decision. This constitution was in force till Dec. 27, 1843, when the sittings of the cortes were suddenly suspended by a decree; but in 1844 a new cortes was summoned, at which it was proposed that the senators should be named by the crown for life; that the cortes, instead of meeting every year, should only be at the pleasure of the crown; and that the political offences of the press should not be submitted to a jury; and in March, 1845, other regulations were enacted relating to the qualifications of deputies and electors. On the suppression of the Carlist war the cortes were re-established in 1848, with considerable power by Espartero, who became himself the victim of the party feeling prevailing among its members. Since that time they have been accustomed to meet, and to debate, but have generally been under some sinister influence, either the power of the army or the corruption of the ministry, and have on the whole played a very insignificant part in the history of their country during the last twenty years.

The history of the cortes of Portugal is nearly the same as that of those of Spain, only that the towns which sent deputies were comparatively fewer, seldom more than ten or twelve at a time, and the influence of the privileged orders greater in proportion. The nobles having by degrees become courtiers, as in Spain, the kings reigned in fact absolute. In 1820, while King João VI. was in Brazil, a military insurrection broke out in Portugal, and a constitution was framed in imitation of the Spanish one of 1812, but it was soon after upset. For an account of these transactions see Kinsey's 'Portugal Illustrated,' 1828. After the death of King João, his son, Don Pedro, gave a charter to Portugal, establishing a system of popular representation with two houses; this charter was afterwards abolished by Don Miguel, again re-established by Don Pedro; and has been maintained, with a short interruption in 1836, by Queen Maria and the present king.

The Aragonese, during their period of splendour, extended their representative system by brazos or estamentos to the island of Sardinia, then subject to the crown of Aragon, and the institution remained till lately under the name of Stamenti. They were convoked by the crown on particular occasions, chiefly to grant extraordinary supplies, but have been now replaced by a representative assembly, meeting at Turin. [SARDINIAN STATES, in GEOG. DIV.]

CORTICIN. An inodorous, tasteless substance, said to exist in the bark of the aspen-tree.

CORVUS, the Crow, sometimes *Hydra et Corvus*, because this constellation, in fact, contains a part of the body of Hydra, on which the bird rests. In Aratus, Hydra, Crater, and Corvus form one constellation. There are mythological stories, apparently not very ancient, in Hyginus.

naracter.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
α	1	4090	4
ε	2	4097	4
γ	4	4124	3
δ	7	4211	3
β	9	4234	3

CORYDALINE ($C_{45}H_{27}NO_{18}$?). An alkaloid contained in the root of the *Corydalis bulbosa*, as also in snake-root (*Aristolochia serpentaria*). It is a gray, light, non-coherent substance, soluble in alcohol and ether, but insoluble in water.

COSECANT, COSINE, &c. [TRIGONOMETRY.]

COSMO'GONY, in the proper sense of the term, is the science of the creation of the world. As the creation of the world was not observed by man, and as it is not possible for man to observe the creation of a world, so cosmogony cannot be a science founded on direct experience, but must necessarily be a philosophical science. But though cosmogony belongs to the department of philosophy, yet, as it requires an accumulation of facts and observations to rest on, it must still be classed under the division of practical philosophy. The ancients not possessing these facts and observations, cosmogony has only become a science in modern times. The German philosopher Kant has denied the capacity of the human mind to entertain this science.

The doctrine of the creation of the world may be considered in three ways; the inquirer either confines himself to the creation of our earth, and reduces cosmogony to geognosy, geogony, speculative geology, and oryctognosy (which latter is a science of itself), or he may merely investigate the creation of celestial bodies, or he may extend his researches to the origin of creative power, and the creation of the elements of matter.

The first of these modes of investigation is pure cosmogony; the second is a union of cosmogony with dynamogony, physiogony, and speculative chemistry and physics. The ancients speculated or dogmatised in both these divisions of the science, with no very satisfactory results. The chief modern cosmogonists may be divided into two classes; first the dogmatists, as Buffon, in his 'Histoire Naturelle;' Wolff, in his 'Cosmologia;' Maupertuis, in the 'Essai de Cosmologie;' Lambert, in the 'Kosmologische Briefe;' Dalberg, in the 'Betrachtungen über Universum;' Berger, in his 'Philosophische Darstellung des Weltalls,' Des Cartes, 'Opera Omnia,' lately edited by Victor Cousin; and Hollbach, in the 'Système de la Nature.' Secondly, the critical cosmogonists, who conduct their inquiries according to the principles of Kant, as developed in his 'Allgemeine Naturgeschichte, und Theorie des Himmels;' and in detached parts of the philosophical systems of Schelling, Hegel, Herbart, and in the 'Naturphilosophie' of Oken, which contains a complete system of cosmogony, dynamogony, and physiogony; and in a work of John Müller, entitled 'Ueber die Entstehung der Welt aus Nichts.'

COSMOGRAPHY (κοσμογραφία), the description of the system of the world, from the two Greek words γράφω, to write, and κόσμος, which signifies the world, or the universe, considered as a system of order. Cosmography, strictly limited, has nothing to do either with the origin and creation of things, which is the subject of cosmogony, or with the metaphysical philosophy of the constitution of things, which is cosmology. It is merely the description of the system of the material world, as it is, or as it appears to our senses. Nor does it comprehend any examination of the separate parts of the system, except in so far as each is connected with the whole, any more than the description of a machine comprehends any account of the wood or iron or other material of which it may be fabricated. Yet this distinction has been sometimes neglected. There is a work, for instance, by Paul Merula, under the title of 'Cosmographia Generalis,' fol. Amst. 1621, which is in the greater part merely a description of the different countries of the earth, or in other words a treatise on geography. In like manner, the English work of Dr. Heylin, first published in 1622, under the title of 'Microcosmos,' and afterwards under that of his 'Cosmography,' is merely a compilation of geography and history. The word cosmography may perhaps legitimately admit of some variety of acceptation, in regard to the extent of what is to be considered the system of the world or of the universe. Of the universe absolutely we can of course predicate nothing; but as anything may be called the whole which can be regarded as complete in itself, so the word universe is applied sometimes to this globe alone, which in one sense is the universe to us, and sometimes to that solar system of which our globe is one of the parts. But the term cosmography might also, without impropriety, be used as meaning a view or description of any separate portion of the entire universe still more extensive than the solar system. The 'Cosmos' of Baron Alex. Humboldt is one of the most satisfactory examples of the proper mode of treating of cosmography, in its most comprehensive sense.

COSTS, in the technical sense of the word, are the expenses incurred by parties in proceedings at law or in equity. In civil actions particular importance and interest attach to the principles and practice concerning them, since though in themselves merely incidental and subordinate to the main cause of action, it not unfrequently happens that they become a prominent object of anxiety and contention. Under the head *Costs in civil actions* may be considered the steps by which the mutual rights and liabilities to them were originally created, and have been subsequently qualified; the modifications to which those rights and liabilities are subjected by reason of the particular character in which the parties may sue or be sued; and the practice by which the amount of costs is ascertained and controlled.

At common law neither the plaintiff nor the defendant was entitled to recover costs the one from the other, as a matter of right; the only liability which attached to the unsuccessful party, beyond the direct result of the suit, being an amercement imposed upon him for his false complaint or defence. If, however, the plaintiff succeeded, the jury were at liberty, and were usually directed, to take his costs into consideration in estimating the amount of damages. And before there was any legislative enactment upon the subject, it is said that the justices in eyre, and afterwards those of assize and nisi prius, were in the habit of assessing the plaintiff his costs, exclusively and apart from the damages.

The first statutory provision with respect to costs was that of the Statute of Marlbridge (52 Hen. III. c. 6), which gave them to the defendant in one particular case (wardship in chivalry), which became extinct in the reign of Charles II. Then came the Statute of Gloucester (6 Edw. I. c. 1), by which a successful plaintiff recovered the costs of his suit in all cases where he was previously entitled to recover damages. The right to costs under this statute, which were styled costs of *increase*, was entirely independent of the amount of damages recovered. The consequence of this being found mischievous, power was given to the judges by the stat. of 43 Eliz. c. 6, s. 2, in all personal actions, except such as concerned the title or freehold of land, and those of battery, where the debt or damages did not amount to 40*s.*, to grant a certificate of that fact, and to award to the plaintiff no greater or more costs than the sum of the debt or damages recovered should amount to, but less at their pleasure. Owing to the indisposition of the judges to grant certificates under this statute, it was for some time wholly inoperative, and it was therefore enacted by the statute of 22 & 23 Car. II. c. 9, s. 136, that in all actions of trespass, assault, and battery, and other personal actions, where the jury should find damages under 40*s.*, the plaintiff should recover no greater costs than damages, unless the judge should certify that an assault and battery were sufficiently proved, or that the freehold or title of land was chiefly in question. It has been observed of this statute, with great show of reason, that the legislature intended by it to preclude the plaintiff absolutely from recovering full costs, where the damages were below 40*s.*, in all personal actions but those specially named, and even in them, unless the judge *gave* them by a certificate under the Act. It received, however, a different construction from the courts, by which it was held to apply to those actions only in which it was possible to grant the prescribed certificate, all others being left to the provisions of the previous statute. Wherever therefore it appeared, either from the form of the action, or from the pleadings, or the nature of the case, that no question of a battery, or of freehold or title of land, could possibly be involved in the dispute, so as to give the judge the option of certifying, it was held that the plaintiff would be entitled to full costs, notwithstanding the statute.

By the statute of 8 & 9 Will. III. c. 11, full costs were given to the plaintiff in actions of trespass, where the judge should certify that the trespasses were wilful and malicious.

In the particular case of actions for oral slander of the person, where the words are actionable in themselves, either from their own intrinsic meaning, or from having been spoken of a party in reference to his profession or trade, the plaintiff's right to more costs than damages, where the latter fall short of 40*s.*, is absolutely barred by the statute of 21 Jac. I. c. 16.

Hitherto those statutes only have been considered which relate to a *plaintiff's* right to costs. The first Act which recognised the interest of *defendants* in personal actions was one passed in the twenty-third year of Henry VIII., which, jointly with another Act of the reign of James I., gives costs to the defendant where the plaintiff is nonsuited or has a verdict passed against him, in all cases in which the plaintiff would have been entitled to them if he succeeded. By a subsequent enactment of the reign of Elizabeth, costs are given to the defendant where the plaintiff is guilty of delay or discontinuance in his suit. The defendant's right to costs was farther extended by the 3 & 4 Will. IV. c. 42, which gives him costs in cases where the plaintiff enters a *nolle prosequi*, or remits his suit. The same Act gives reasonable costs to one or more of several defendants sued together, who shall have a *nolle prosequi* entered as to him or them, or upon trial of the action shall have a verdict pass for him or them, unless the judge shall certify that there was reasonable cause for joining him or them in the action.

In the late very important changes which have been made with regard to the mode of pleading in civil actions, the courts have taken great pains to provide a more equitable apportionment of costs between the parties than was formerly observed. It is enacted (C. L. P. Act, 1852, s. 81) that the costs of any issue, either of fact or law shall follow the finding or judgment upon such issue, whatever may be the result of other issues.

To render the costs of legal proceedings in some degree at least commensurate with their object, there is a standing direction to the taxing officers to tax a successful plaintiff's costs upon a lower scale where he has recovered a debt of less than 20*l.*, unless a certificate for costs upon the ordinary scale be granted by the judge of the superior court before whom the cause was tried.

In actions brought in the superior courts for causes within the ordinary jurisdiction of the county courts, where the plaintiff recovers a sum not exceeding 20*l.*, in actions based upon contract, or not exceeding 5*l.* in actions based upon tort, he has judgment to recover that sum only, and no costs, except where a judge certifies that there was sufficient reason for bringing the action in such superior court, or where an order for costs is made by a superior court, or a judge thereof, upon the ground that there was such sufficient reason, or that no plaint could have been entered in a county court, or that the action was removed into the superior court by certiorari, or that the plaintiff dwelt more than twenty miles from the defendant, or that the cause of action did not arise wholly or in some material point within the jurisdiction of the court within which the defendant dwelt or carried on his business at the time of the action brought, or that an officer of the county court was a party, otherwise than in respect of claims to goods seized under county court process or to their proceeds. Where no such certificate or order is made a successful defendant is entitled to his costs as between attorney and client.

The provisions of "The London (City) Small Debts Act, 1852" (15 & 16 Vict. c. 77), which regulate the costs recoverable in the superior courts in cases within the ordinary jurisdiction of the City Small Debts Act, are very peculiar, but are of too limited application to justify explanation here.

As to the manner in which the right or liability of a party to costs may be modified by the particular character which he sustains, a striking instance used frequently to occur in former days, in the case of plaintiffs suing in the representative character of executors or administrators. In favour of such parties it was held, that wherever they sued for a cause of action which they could not have recovered in their individual capacities, they would not be liable to the defendant for costs, upon being nonsuited, or having a verdict pass against them. For some time a notion prevailed that this exemption proceeded from a consideration of the degree of ignorance under which they were supposed to lie with respect to the contracts or other causes of action of the deceased parties whom they represented. But the sounder opinion at length obtained, that the true cause of this freedom from liability was to be found in the particular language of the different enactments bearing upon the subject.

After having been long considered too extensive, this privilege has been effectually curtailed by the 3 & 4 Will. IV. c. 42, s. 31, which puts executors and administrators upon the same footing with other plaintiffs, unless the judge before whom the action shall be brought, or a judge of any of the superior courts, otherwise orders. The disposition of the courts, with regard to this Act, is not to interpose in behalf of the plaintiff, unless the defendant has brought the action upon himself by practising something like a fraud upon the plaintiff, thus discouraging the practice formerly prevalent of bringing merely speculative actions in a representative character, under the shelter of immunity from costs.

In penal or *qui tam* actions, the plaintiff's right to costs depends altogether upon the provisions of the statute which creates the cause of action. There are also express statutes which impose additional liabilities upon a plaintiff of this class under certain circumstances. There are, moreover, numerous enactments relating to costs in particular actions, and in actions against persons clothed with special statutory authority, too minute for detail here.

When a party has obtained the permission of the court to sue *in formâ pauperis*, that is, to be provided, on account of his poverty, with all necessary writs, as well as with counsel and attorney, gratis, he is not liable to pay any costs, nor is he entitled to receive them unless by order of the court or a judge.

The mode in which the amount of costs payable between the parties is ascertained, is by taking the Nisi Prius records, with all the papers, briefs, and other documents, to the proper officer, or taxing master, of the court, who then taxes the costs according to a certain prescribed scale, allowing or disallowing particular charges at his discretion, subject to review by the court or by a judge sitting in chambers.

Hitherto we have only considered *single* costs, or those derived from the Statute of Gloucester. In some cases *double* and *treble* costs are expressly given by statute; and wherever a statute gives double or treble damages, the plaintiff was also entitled to double or treble costs. But now, by 5 & 6 Vict. c. 97, s. 2, a party entitled to *double* or *treble* costs under any public general Act is to receive in lieu thereof reasonable indemnity as to his costs, to be taxed by the ordinary officer; and all provisions in local or private Acts for *double* or *treble* costs are, by sec. 6 of same Act, repealed.

Such are some of the principal matters relating to costs in actions at law,—a subject so purely technical in its nature, that any minute inquiry into its rules and mode of administration would be foreign to the purposes of this work. Between the courts of equity and those of common law there is this important difference with respect to costs, that the former are not bound by any of the enactments above enumerated, but are invested with a discretionary power upon the subject. In the exercise of this power they are guided, not merely by the event of the suit, but by a consideration of its real merits, and of the interests of the parties concerned. Thus, although the party failing is *primâ facie* liable for the costs, he will be relieved from the burden if he has prosecuted the suit in the conscientious discharge of a duty imposed upon him as a trustee for the benefit of others. On the other hand, a party proceeding erroneously will not be allowed the costs of his erroneous proceedings, even though the decree of the court may ultimately be in his favour.

In proceedings whereto the crown was a party, the old rule was that it neither received nor paid costs. This was long felt to be both oppressive in practice and unjustifiable in principle; and by a recent statute, 18 & 19 Vict. c. 90, it is provided that in all informations, actions, suits, and other legal proceedings of a civil or *quasi* civil character, the crown shall receive or pay costs, according as it succeeds or fails.

In *criminal proceedings* the rights and liabilities of parties to costs depend altogether upon express statutory enactments. With a view to forward the ends of justice, provisions have been made by various statutes to defray, out of the funds of the county, at the discretion of the court, the expenses incurred by prosecutors and their witnesses in cases of felony.

For the practice respecting costs in special cases, see the various titles throughout the work,—BANKRUPTCY; CERTIORARI; MANDAMUS, &c.

(See generally, Archbold's 'Practice of the Court of Queen's Bench,' by Prentice, 10th edition; and Blackstone's 'Commentaries,' by Kerr, title *Costs*, in Index.)

COTARNINE. [OPIUM, *Alkaloids of.*]

COTE' DROITE, COTE' GAUCHE, the names given to the two great divisions of the Chamber of Deputies, or French representative assembly, during the existence of the Charte. They took their names from sitting on the right or left of the president, and represented what in the English House of Commons are styled the ministerial and opposition benches. There were also subdivisions of the extrême droite and the extrême gauche, the centre droite and the centre gauche, denoting the ultras of each party, or the independents. In the present chamber of deputies these party distinctions are out of use; under the restrictive system of election the opposition members are too few to constitute a division.

COTTAGE ARCHITECTURE. The term "cottage" has so very wide an application that it is difficult to assign any very definite limits to the style of architecture appropriate to it. There are "cottages with three-stalled stables, cottages of gentility," and there are cottages designed expressly for the residences of the labouring agricultural population in those districts where the wages of day labour are so low as to keep their recipients constantly on the verge of poverty. The former of these classes of cottages tread so closely on the heels of pleasure or country residences, that the consideration of their construction may fairly be left out of the present article; and it is proposed in the following remarks simply to notice the principles which should be observed in the construction of labourers' cottages,—starting always with the assumption that the proprietor of the land to be cultivated attaches more importance to the happiness and the respectability of the parties he employs than he does to the nominal money rental he may derive from his cottage property. Unfortunately, it is almost always the case that the wages of agricultural labourers are so low that they cannot afford to pay the money-rents which would be required to make cottage-building a remunerative and self-supporting operation; and therefore it is that attention should be directed towards rendering the contribution of the landlord as small as possible, by adopting every possible economy consistent with the attainment of the object of improving the moral condition of the tenants; and to endeavouring to bring the really remunerative rent within the capacity of the tenants, so as to develop in them the habits of independence and self-reliance, which are at the bottom of all honest and noble character. On these principles it is possible that the artistic beauty of the cottages may suffer, but so long as the residences themselves possess the requisite conditions of healthiness and comfort, they fulfil the strict necessities of the case; and it does seem to be desirable that anything beyond the details required for such purposes should be avoided, as they give a species of eleemosynary character to the houses which tends to degrade their inhabitants.

The style of architecture to be adopted in cottage-building must mainly be influenced by local considerations; that is to say, it must be regulated by the nature of the materials employed, by the surrounding scenery, or by any associated buildings. It is, however, essential to observe, that even in the most picturesque scenery simplicity and economy of construction must be studied rather than abstract picturesque beauty of outline. These common-place merits, it is to be observed, can be attained simultaneously with a considerable amount of architectural expression, if only due attention be paid to the choice of materials; but, unfortunately, it has been too often the case that great sacrifices have been made, and very complicated and costly details have been introduced, for the avowed object of giving a picturesque appearance to buildings which, generally speaking, are the most consistent with the ends they are designed to fulfil when they are simple and almost plain in their outlines. It should therefore be the aim of the architect to give to his cottages an air of substantial comfort; to produce broad, massive effects, without allowing any details to thrust themselves into notice. The shadows of his composition should be bold, without rendering necessary any peculiar modes of construction,—nay, rather they should be produced by the essential constructive parts of the building itself; whilst the style adopted should be such as to admit of the simplest mode of execution of the joiners' work and other practical details. Thus, for instance, it is preferable to make the roofs with broad, overhanging, dripping eaves, than to construct them with boxed gutters and parapet walls, and to make the openings of doors and windows with square heads rather than with circular or pointed arches; and these precautions may be observed whether the Italian or the later Gothic styles of architecture be adopted. As a general remark, it may however be stated, that extreme archæological correctness need not be aimed at in the construction of cottages; and that the main practical considerations which ought to be present in the architect's mind are, that the rooms themselves in the interior should be comfortable and well ventilated.

The labourers' cottages, intended for the habitation of married men and their families, should always present a living room large enough for the whole family to meet, and to cook their victuals in; a larder; a coal or wood store; and a privy or water-closet; together with a sufficient number of bed-rooms to allow of a separation at least of the sexes; and perhaps, as a rule, it may be said that at least three bed-rooms are required in order to maintain the proper decorum of family life; whilst certainly provision must be made for the removal, at once, from the inhabited part of the dwelling, of the refuse of the whole establishment. The minimum size which seems to be admissible for the living room of a family cottage, such as is above described, may be taken to be 13 feet long by 10 feet wide in the clear, by 10 feet high from floor to ceiling; and the sleeping apartments should be proportioned so as to allow, as nearly as may be, about 1000 cubic feet of space for each occupant, although, unquestionably, a much smaller space might occasionally be tolerated; and indeed, if efficient means of ventilation be provided, the cubical space per individual above allotted may safely be diminished one half. Of course, it would be preferable to erect the cottages of agricultural labourers on the system of what may technically be called *detached* or *semi-detached* cottages; but local and economical considerations must ultimately determine the selection of the practical solution to be given to this or to other similar questions. It is to be observed, nevertheless, that there is an economy in building a *row* of cottages rather than a series of detached residences; because, in the former, the construction of party-walls must always be less costly than the construction of a series of external walls; and therefore even the semi-detached cottages would, as commercial speculations, only be resorted to when it was known that the habits of the poorer classes of the population they were intended to lodge were such as to warrant the belief that they themselves would truly appreciate the advantages in the way of privacy which it confers. Precautions must at all times be taken to ensure a copious supply of water; provision must be made for washing and drying clothes, and, if possible, also for baking; a tool-house should be formed; but, before and above all things, attention should be directed to securing the efficient ventilation of the different apartments.

The reader may consult on cottage architecture, Loudon, 'Encyc. of Cott. Arch.,' 8vo, Lond., 1842; Gwilt's 'Encyc. of Arch.,' 8vo. Lond. 1854; 'Report of Poor-Law Commissioners on an Enquiry into the Sanitary Condition of the Labouring Population,' 1842; Roberts, 'Dwellings for the Labouring Classes,' 8vo, Lond. 1850.

COTTON. In the NATURAL HISTORY DIVISION of the ENGLISH CYCLOPÆDIA, under the heading GOSSYPIUM, is given an account of the botanical characteristics of the genus of plants to which the cotton tree belongs; and under COTTON, in the same division, will be found a description of the most important among the many species of that genus. It now falls within the scope of the present division to continue the subject, by treating of the most gigantic manufacture, perhaps, which the world has ever witnessed in one single country—the cotton manufacture of Great Britain; together with the developments of the same system in other countries. To render this large subject intelligible to the reader, it will be necessary to adopt a certain mode of classification. First, will be presented a general view of the operations for maintaining and increasing the annual supply of raw cotton for the use of manufacturers; next, will be given a popular description of the machines and processes of manufacture; and lastly, will be noticed the trading operations connected with the manufactured goods, in relation to quantities, kinds, persons, and places. These subjects will be treated in three successive articles:—COTTON CULTIVATION AND SUPPLY; COTTON MANUFACTURE; COTTON TRADE AND CONSUMPTION.

COTTON CULTIVATION AND SUPPLY. A striking picture of the present state of the cotton supply for the factories of Great Britain was presented by Mr. Dawson, in a paper read at the meeting of the British Association in 1856, 'On the Connection between Slavery in the United States and the Cotton Manufacture of the United Kingdom.' His statistics and reasonings tended to establish these five propositions: 1st. That cotton, from the conditions of climate necessary to its culture, cannot be grown in Europe; but that, on the other hand, with the single exception of the factories of the New England States of America, it is, and must long continue to be, manufactured almost exclusively in Europe. 2nd. That the present supply is chiefly raised, and for the present must continue to be raised, by slave labour; seeing, that while for fifty years we have sought over the whole earth for cotton, we have during that time continued to obtain from the slave states of the American Union a continually increasing proportion of our entire supply. 3rd. That two-thirds in number at least of the slaves of the United States have been called into existence, and are now directly or indirectly maintained, for the supply of cotton for exportation. 4th. That of the cotton thus exported, three-fourths at least in value are raised for, and sent to, this country alone. 5th. That of the entire quantity we import, four-fifths at least in value are thus derived from the United States. The summary assumed the following remarkable form: Two-thirds of all the slaves in the cotton-growing districts of the United States are employed in supplying raw material for the cotton manufactures of our own country; and four-fifths of all the cotton-workers in Lancashire and other northern counties are dependent on the supply which those slaves raise. Some of these statements and ratios may not be strictly correct, but the general result is sufficiently near the truth.

By what steps this gigantic state of things has been produced, and in what direction future changes will have to be sought, we shall now proceed to show, by a rapid glance at the chief cotton-growing districts of the world. This, however, may usefully be preceded by a few paragraphs relating to the culture.

The finest kind of cotton, which commands the highest price, is called "Sea-island cotton," from the circumstance of its having been first cultivated in the United States of North America, in the low sandy islands on the coast, from Charleston to Savannah. This variety will not flourish at a distance from the sea, and it is said that its quality is gradually deteriorated in proportion as the plants are removed from "the salutary action of the ocean's spray;" it succeeds best in South Carolina, Georgia, and Florida. This cotton is composed of filaments longer than those of any other variety; which circumstance, joined to its even and silky texture, fits it for the production of the finest yarns. The seed is black, and in the southern states of North America it is thence frequently called "black-seed cotton," to distinguish it from the short-staple cotton produced in the interior of those states, and which, from a like natural cause, is distinguished as "green-seed cotton." The seed of the sea-island cotton is sown every year; but the plant, when cultivated within the tropics, will live and yield harvests for several years in succession. It is supposed to have come originally from Persia. The plant was taken from the little island of Anguilla to the Bahamas for cultivation, and was first sent thence to Georgia in 1786; but it is not said how the seed found its way to Anguilla. The supply is small, and the price always relatively higher than other kinds. "Upland" or "Bowed Georgia cotton," the green-seed kind, has received its name of *upland* to distinguish it from the produce of the islands and low districts near the shores. The expression *bowed* was given as being descriptive of the means employed for loosening the seed from the filaments; this was accomplished by bringing a set of strings, attached to a bow, in contact with a heap of uncleaned cotton, and then striking the strings so as to cause rapid vibrations, and thus open the locks of cotton and cause the seeds to be easily separable from the filaments. The remaining kinds of cotton now brought to English markets are distinguished by names so plainly indicative of the countries of production, that it is not necessary to offer any description of them with that view.

To illustrate the operations in a cotton-field, it will suffice to select two examples—the short-staple upland cotton of the United States, which forms the bulk of all the cotton used in England; and the long-staple sea-island cotton, used for our finest muslins. The cultivation of all other kinds may be inferred from those two, sufficiently near for the wants of the general reader.

For cultivating the *short-staple upland* cotton, the planter prepares his land with a small plough, drawn by one or two mules, which walk rapidly over the ground. A negro slave usually guides the plough. This preparation takes place during the winter months; it consists of a ploughing, a harrowing, a second ploughing, and a heaping-up into flat-topped ridges. The sowing takes place between March and May: the earlier the better, provided the winter frosts are gone. Some planters deposit the seed in furrows opened by a light plough; while others carefully dibble the seed at equi-distant intervals. The dibbling is considered the better of the two methods. A man proceeds rapidly along, making holes in the ridge with his dibble at intervals of twelve inches; a woman follows him, dropping five or six seeds in each hole; and a boy or girl comes in the rear, covering the holes with earth by a light hoe. By much practice under the eye of a vigilant overseer, the negroes become very expeditious in these processes. Drilling machines have not yet been found to work well; for the upland cotton-seeds being furred by the lint or fibre still adhering to them, and being very adhesive one to another, do not deliver well from the drill. When the young plants shoot forth, the weakest are cut away, leaving only two in each hole; and the holes which have failed are supplied by resowing; but the chief attention is bestowed on frequent weeding, which is essential to the cleanness and excellence of the crop. The weeding is mostly effected with the aid of light and straight hand-hoes. If the crop has pretty well escaped the attacks of vermin, insects, and storms, it is ready for picking in August. The plant continues to produce and ripen its bolls of cotton until the frost comes; and it is therefore a matter of nice calculation with the planter to delay his picking, so as to get as much as possible, and yet not to run the hazard of a frost. During the picking season, every hand is brought into requisition. Each picker fastens a bag round the waist, into which he (or she) throws the cotton bolls as they are picked; and when the bag is full, it is emptied out on a sheet; when the sheet contains as much as it will hold, it is carried to the weighing-house. A good hand will in a fair field pick 200 lbs. a day; but the average is less than this. Successive pickings are made as the bolls grow and ripen, until the quantity no longer pays for the labour. It is exceedingly difficult to state the average produce per acre: much of the land in Carolina and Georgia will only yield 100 lbs.; an excellent return in these states is 200 lbs.; the average in the teeming valley of the Mississippi is 400 lbs.; while careful culture on special spots is rewarded with a much higher return. Some of the plants, under favourable circumstances, will yield 400 bolls in one season, weighing 4½ lbs., which will afford 1¼ lb. of ginned or cleaned fibre. The picking requires some dexterity; it is essential to get every particle of cotton from the boll at one pull, without any leaves or other foreign matter adhering to it. It is laborious work, on account of the stooping required; the pickers' hands become sore, and there is a liability to colds and rheumatisms, owing to the wetness of the bushes in the cold autumn mornings, occasioned by heavy dews at night. Some planters provide their slaves with waterproof aprons and skirts for this season; but others are not so considerate. When sufficient cotton has been collected, a machine called a *gin*, which costs the planter from 16*l.* to 24*l.*, is employed to separate the fibre from the seed. A screw-press, costing from 30*l.* to 50*l.*, is next employed to press the fibre into bales of about 400 lbs. each. Directly it is packed, the planter sends his cotton to market; and from the month of August to November the roads exhibit trains of waggons, carrying the cotton from the plantations to the shipping ports or the river stations. Mr. Leonard Wray, who has visited cotton plantations in various parts of the world, says, in relation to the upland cotton of America: "It is usual in the States to calculate the crop at so many acres to the working 'hand' (as the slave is denominated). Thus, a cotton-planter with 50 good working hands, great and small, and 25 mules, would consider his strength equal to 500 acres of cotton and 400 acres of corn, or to 1000 acres of cotton alone, provided extra hands are allowed for picking the crop. This is the general mode and rate of calculation where the soils yields about 200 lbs. of ginned cotton to the acre; making, therefore, to the 'hand' 2000 lbs. of cotton, which, at 5*d.* per lb. on the spot, is worth about 40*l.* sterling, besides the value of the Indian corn raised." Most cotton-planters grow corn enough for the supply of their slaves, and some have a large surplus for sale.

The *long-staple* or *sea-island* cotton, eagerly bought at a high price by the spinners of fine yarns for muslins and lace, is cultivated in the same general way as the short-staple, but with peculiarities which need only be glanced at here. According to the nature of the ground, as to level, moisture, and stiffness, the planter regulates the height of his ridges, the kind and amount of manure used, and the closeness of sowing. The produce is so much more valuable than upland cotton, that 200 acres of the one will have a money value equal to 1000 acres of the other; and thus it pays the sea-island cotton-planter to bestow much care on all his operations. The sea-island seed would admit of being sown by the drill; but there is very little machinery employed in the slave states, and most of the sowing is still effected by the dibble. The picking, as for the short-staple, usually commences in August, but requires much more care and attention. When picked, the bolls are slightly dried and examined to reject any which have become discoloured or injured in fibre. They are next kept for some time covered over in large heaps, to preserve the oiliness, strength, and gloss of the fibre, which would be injured by much exposure to the air; but this operation requires much caution, to prevent fermentation by heat, and the soiling of the fibre by the oozing out of oil from the seed. When the time for sending to market arrives, the cotton is taken from the heap and subjected to the ginning process, as a means of separating the fibre from the seed. The quantity of sea-island cotton grown being much smaller than that of upland, the processes are conducted on a less extensive scale; and the separation is usually effected, not by the gin, but by a more primitive instrument called the *churka*, similar to that which is employed by the Hindoos. This churka consists of two wooden rollers, eight or nine inches long by one inch in diameter, placed horizontally and in contact, one above the other; when these revolve, the fibres of cotton are drawn between them, and the seed left behind. The cotton is fed in by hand, while the rollers are made to rotate by means of a treddle. The machine will only clean from 12 lb. to 20 lb. in a day. Most of the planters adhere to this primitive method, under an impression that a more rapid or rough treatment would injure the delicate fibre of this highly-prized cotton. The correctness of this opinion is however denied by the more enterprising among the number, who use larger machines worked by steam-power, without any deterioration of the material. The cotton, cleared from its seeds, motes, and discoloured particles, is then pressed down into long cylindrical bags, quite different in appearance from those employed for upland cotton, and with less intense pressure, lest the fibre should be injured. The small quantity and high price of this variety render the market more uncertain than that of the coarser kinds. Mr Wray says on this subject: "After his produce is all fairly bagged, the difficulties of the planter are not ended; he has sometimes considerable trouble and has to wait a long time before he can find a buyer for it. Not unfrequently he has to ship it to Europe, and encounter manifold risks and chances. This, indeed, constitutes the greatest disadvantage under which he labours. The upland cotton-planter makes his bale of cotton to-day, and to-morrow he has cash in hand for it; or perhaps he is even paid for it before it has left the trees. Not so, however, with the sea-island cotton-planter; he is obliged to exercise all his patience before he can sell his crop; and in the meantime, although lord over 200 to 400 slaves and a fine estate, he is very probably compelled to use his broker's name in obtaining cash from the banks wherewith to pay the current expenses of his estate." The sea-island cotton yields more seed than the upland, and this seed is more smooth, clean, and oleaginous, thereby being better fitted for yielding cotton-seed oil. The produce is much less per acre of sea-island than of upland; 200 lbs. of clean fibre is about the maximum, while some fields barely yield 50 lbs.; the hands pick smaller quantities per day, and conduct the picking more carefully. The muslins, famous for their fineness, spun and woven by the Houldsworths and other firms who attend more particularly to this kind of work, are mostly made of sea-island cotton. Small parcels of special excellence will sell for 3*s.* or 4*s.* a pound, while French lace-makers will sometimes give as much as 6*s.* One pound of such cotton can be spun into a *thousand miles* of yarn, which may be wrought up into lace worth 250*l.*

The present may be the most convenient place in which to advert to certain auxiliary commercial advantages resulting from the cultivation of cotton,—advantages not yet much attended to, but which may in future years possibly become very important. The fibre is, of course, the chief product for which the cotton-plant is cultivated, but it is not the only one. The plant yields a pure, bland oil, equal to that of the olive; an oil-cake, most excellent for feeding cattle; and a fibre from the bark, which would possess commercial value if collected and shipped. Even in the greatest of all cotton-growing countries, the United States, the oil contained in the seed has scarcely yet been rendered available; but Dr. James Coxe, of New Orleans, has (in 1857) drawn the attention of his countrymen to the subject. His estimate may be somewhat overdrawn, as such estimates frequently are; but the figures presented are certainly worthy of notice. The average cotton crop of the United States may be roughly given at 3,000,000 bales of 400 lbs. each, or 1,200,000,000 lbs. of ginned cotton. To each pound of fibre there are 3 lbs. of seed, making 3,600,000,000 lbs. of seed in all. Of this enormous quantity, 1,800,000,000 lbs. are retained for re-sowing, including waste. The remaining 1,800,000,000 lbs. are available for yielding oil and oil-cake. It is found that 100 lbs. of seed will yield 2 gallons of this oil, worth 4*s.* per gallon at New Orleans and 6*s.* at New York. After the pressure there will result 48 lbs. of oil-cake, equal in quality to that of linseed. There will furthermore remain about 6¼ lbs. of oleaginous refuse available as soap-stuff, capable, when combined with very cheap alkali, of making 20 lbs. of useful soap. Summing up these items, they present the following money values: 36,000,000 gallons of cotton-seed oil at (say) 75 cents (3*s.* 2*d.*), 5,400,000*l.*; 864,000,000 lbs. of cotton-seed cake, at 1 cent (½*d.*), 1,728,000*l.*; and 106,000,000 lbs. of soap-stuff, at 3 cents (1⅓*d.*), 636,000*l.*; making a total of 7,764,000*l.* The bark-fibre is another prospective source of profit, the value of which remains to be determined. It has not yet been shown whether the oil is most likely to be useful as a salad oil, a fuel for lamps, a material for soap, an oil for leather-dressing, or a lubricator for machinery; but all these matters would speedily be settled if the oil became a regular marketable commodity. The oil-cake maintains a good place as a cattle-food, seeing that it contains from 9 to 16 per cent. of oil and 25 to 30 per cent. of albuminous compound.

We are now in a position to glance at the several cotton-growing countries, and to ascertain how much cotton they grow annually, what proportion of it is sold for manufacture in Great Britain, and what are the chances for an increased supply.

United States Cotton.—It is a remarkable fact that, while the production of this article has increased at a great rate in America, it has diminished in many other countries. This result has been attributed to various causes; among which may be mentioned, the good quality of American cotton, the low price of land there, and the great improvements that have been made in cleaning the cotton from its seed by means of Whitney's saw-gin, introduced in 1793. It is evident, however, that the greater part of these advantages might have been shared by many other countries in which the soil and climate are equally favourable for this branch of husbandry; and it will probably be more in agreement with the fact if we attribute the success of the American planters to their greater intelligence and industry, seconded by the commercial enterprise by which their country is characterised. Land fresh brought under cultivation in the United States will yield double the produce obtainable in the older states. One able-bodied labourer is sufficient for each eight acres of land, if assisted in the lighter part of the work by the aged and infirm, and the young people who belong to their families; the whole will, at the same time, be able to cultivate from five to eight acres of provision ground. The proportion of able-bodied labourers in each 100 of the entire working population of the cotton-growing districts in America, was estimated a few years ago at 32; the proportion of young persons not yet arrived at their full strength, and of elderly people still capable of some degree of labour, 25; the remaining 43 being composed of children under 14 years of age, and superannuated persons, none of whom are capable of any but very light work, such as weeding and picking the cotton. There is reason to believe, however, that these ratios vary at different times. It was estimated in 1836, that the whole quantity of land cultivated for cotton in the United States was two millions of acres; that the capital employed for the purpose was 800,000,000 or 900,000,000 dollars; and that the whole number of persons engaged in field labour, picking, and otherwise assisting in the cultivation of cotton, and raising their own provisions, was about 680,000. If to these were added the aged, the infirm, and the very young children composing the families of the labourers, besides overseers, owners, and their respective families dependent on the cotton crop, it was supposed that a million of persons were at that time engaged in the growing of cotton in the United States. Of later estimates we shall speak presently.

The extension of the cultivation in the United States is noteworthy. In the year 1786 no part of our supply was obtained from that country; indeed it was not until the year 1800 that the amount thence obtained became otherwise than insignificant. During the present century the advance has been quite unprecedented. In the eight years 1850 to 1857, both inclusive, the produce rose to millions of *bales* annually. To appreciate the full force of these numbers, it may be well to notice that the weight of an average bale of United States cotton varied in those years from 418 lbs. to 445 lbs., giving a mean of about 430 lbs.* The total produce at the following periods, with the portion of it which was exported from the United States to Great Britain and other countries, was (in round numbers), as follows:

	Total Produce.	Exported.
	Bales.	Bales.
1850	2,204,000	1,589.000
1854	3,035,000	2,318,000
1857	3,057,000	2,251,000

The difference between the total produce and the quantity exported represents pretty nearly the quantity worked up in the cotton mills of the United States. Applying the mean of 430 lbs. per bale, we shall find that on an average of the eight years, 1850-1857, the United States grew 2,960,000 bales, or 1,272,000,000 lbs. of cotton annually, of which 2,290,000 bales or 985,000,000 lbs. were sold to other countries.

The prices of United States cotton have varied considerably. In the year 1806 they ranged from 15*d.* to 24*d.* per lb.; in 1820, from 11*d.* to 17*d.*; in 1830, from 7*d.* to 9*d.* In 1845 the quality called "middling bowed" was 4⅜*d.*; and in 1848 it was 4¼*d.* Taking all the qualities together, the average price varied, in the eight years from 1850 to 1857, at New York, from 4¼*d.* to 12¾*d.* per lb., and the aggregate yearly values varied, in round numbers, from 21,700,000*l.* to 36,000,000*l.*, which was the value in 1857. When the price at Liverpool is 4¼*d.* per lb., it is considered that this is made up thus: 3*d.* for all expenses and profit of growing, and 1¼*d.* for further expenses till warehoused at Liverpool.

In 1857 the cotton manufacturers of Great Britain became very uneasy at their prospects of a supply of raw material. Their dependence on the United States was rendered every day more and more evident. Deficient crops and increasing demand drove up the price from 8·74 cents in 1855 to 12·75 cents in 1857. The American planters actually received most money in the year when the crop was smallest—showing how much there was in the trade partaking of the nature of a monopoly: a monopoly brought about, however, by our exclusive or protecting legislation. The English demand began to overtake the American supply about the year 1845; and ever since that date the state of the cotton crops in the United States has been a subject of yearly anxiety to the Lancashire manufacturers. What foundation there may be for hopes in other quarters, will be seen in the third article of this series; but the pressing question with manufacturers at present is—Can the United States produce be so increased in quantity as to be lessened in price? The chief cotton States are Louisiana, Alabama, South Carolina, and Georgia; these produce five-sixths of the total quantity. It may be well to give, for two recent years, the actual quantities in the eight cotton-producing States:—

	1856.	1857.
	Bales.	Bales.
Louisiana	1,661,438	1,435,000
Alabama	675,788	403,177
South Carolina	495,976	397,331
Georgia	369,445	322,111
Florida	144,404	136,344
Texas	116,078	87,882
North Carolina	26,098	27,147
Virginia	20,458	23,773

Some of the planters, believing England to be wholly at their mercy, advise a restriction rather than an extension of growth, in order that prices may be driven up still higher and higher. The merchants of New York, New Orleans, and the other shipping ports, however, more interested in the quantity of cotton to be shipped than in the price per pound, are making speculative estimates concerning the probable and possible in the cotton culture. Some computers, glancing at the capabilities of various parts of the United States, assert that there are 39 millions of acres of land fitted for growing cotton; that these would require 5 millions of slaves to tend them; and that the produce might be 8000 million pounds of cotton annually—many times the quantity at present worked in all the mills in the world. Hence there has been a sort of special pleading, to the effect that if Christendom would silently acquiesce in a renewal of the slave trade, there might be such an influx of slaves in the United States, and such an increased area of ground laid down in cotton, as to insure a lessening of price to English manufacturers. There are, on the other hand, many reasons for thinking that slave labour is really more costly than free labour; and that we ought to look rather to an increased supply of cotton from the East Indies and elsewhere, than to an extension of slave-raised produce in the United States. It would indeed be grievous if the hateful institution of slavery should be encouraged by the demand of England for raw cotton. There are agencies now at work which encourage a hope that such an evil may be averted.

South American Cotton.—The remaining portion of the American continent, as cotton growing districts, need not engage any lengthened attention.

The immense empire of Brazil does not occupy the rank which is due to it as a cotton-producing country. The total produce in sixteen years only varied from 19,000,000 lbs. to 35,000,000 lbs; 1847 giving the smallest quantity, and 1850 the largest. The average may be about 25,000,000 lbs. This stagnant condition has been attributed to five causes: the abolition of the external slave trade, the dearness of labour, the ravages of insects, the peculiarities of climate, and the inaccessibility of the interior. Writers in the United States, especially those in the slave-holding interest, endeavour to show that all these difficulties must continue to prevent Brazil from being a flourishing cotton-growing country. There are other parties, however, who advocate the construction of a railway from Bahia into the interior, to a large district said to be eminently fitted for the culture. The Brazilian cotton is of good quality; and there certainly seems to be no sufficient reason for a continuance of the present apathy.

The other regions of South America need scarcely be named in connection with this subject. The coast districts of Peru and Chili have been found suitable for cotton cultivation; but the state of industrial enterprise has not hitherto been such as to lead to any considerable production.

West India Cotton.—It has already been stated that England relied upon the West Indies mainly for cotton, at a time when scarcely any was grown in the United States. In 1786 one-third of the English consumption was brought from the British West Indies, one-third from the foreign West Indies, one-quarter from Brazil, and the small remainder from the Levant. The British West Indian portion rose a little during the remaining years of the century; but from 1801 till the present time there has been a signal falling off. The yearly average quantity has gradually decreased from 84,000 bales in the five years, 1806-10, to 11,000 bales in the seven years, 1851-57. These quantities are nearly equivalent to the *total* production; seeing that nearly all the British West India cotton has been brought to Great Britain. The diminution has been attributed to several causes: the withering results of "protection," the maladministration of colonial affairs, supineness on the part of the colonists, and the scarcity of labourers since the abolition of slavery. The last is believed to be the more immediate cause of the backwardness of the culture at the present day. The free negroes will not work hard; as a class they prefer easy labour and small wages. The other labourers are Creoles, Coolies, and Portuguese. The planters are now urgently soliciting the British government for permission to import labourers from Africa, India, and China; but so strong is the apprehension of a revival of the slave-trade, as a consequence of this permission, that a disinclination at present exists to grant the necessary facilities. Demerara declares that she could increase her produce of cotton immensely, if the immigration of free labourers were allowed. Many planters strongly assert that free labour is in the end cheaper than slave labour. Lord Brougham, at the annual meeting of the British and Foreign Anti-Slavery Society, in May, 1858, said: "I find

---

* It is necessary to bear in mind the singular variations in the weight of bales of cotton; otherwise the comparison between the produce of different years and different countries will lead to fallacious results. Some cotton-growing countries uniformly employ larger bales than others; while nearly all have exhibited a gradual increase in weight, possibly due to closer and more perfect packing. The bales of United States cotton have gradually increased from about 215 lbs. to an average of 430 lbs. during the present century. During the last eight years (1851–1858) the average weights of bales have ranged as follow:—

United States' cotton	430	lb. per bale
Egyptian	384	„
East Indies	276	„
West Indies	201	„
Brazilian	181	„

In view of the great preponderance of United States cotton, it is considered that *all* the cotton used in Great Britain may be now (1859) estimated at an average of 400 lb. per bale.

that Mr. Governor Hinckes, writing from Barbadoes in the present year, says that there is an estate which, during the times of slavery, was worked by 230 slaves, and which was sold for 15,000*l.* Since emancipation it has been worked by 60 free labourers and 30 children; it has produced three times the quantity of sugar which it formerly did; and it was sold last year for 30,000*l.*" It is true that this relates to a sugar-plantation; but there is apparently nothing to prevent it being equally applicable to one of cotton.

The foreign West Indies do not call for much remark. Their cotton produce is comparatively insignificant.

East India Cotton.—We now come to the country which, next to the United States, attracts most attention on the part of cotton manufacturers in this country. To India they look for a relief from the commercial shackles which bind them to the United States.

Not only did the natives of India cultivate cotton in times when no such material was as at all known in England; but the amount of produce was and still is really immense. They use woven cottons, not only for clothing, but for beds, cushions, awnings, draperies, hangings, carpets, screens, curtains, tents, ropes, and numerous other articles. It is utterly impossible to say how much is grown altogether, and therefore the estimates become very wide. Dr. White, in 1848, carried it up to 3000 million lbs. annually; but Mr. Ellison, in 1858, brought it down to the more sober level of 1800 million lbs. As even the smaller of these two estimates greatly exceeds the total quantity of all kinds imported into Great Britain, the practical question arises,—Why is there not more East India cotton brought to England? The quantity has certainly largely increased, but still it bears no reasonable ratio to the increase in the United States. In 1857 it reached 250 million lbs., but in 1858 it fell to 133 millions, the decrease being due almost wholly to the disturbance occasioned by the mutiny. Even the highest of these quantities is a very small per-centage of the whole cotton produce in India. It pays to export cotton from India to China; why should it not pay still better to send it to a country where it is so urgently needed as in England? Between 1850 and 1857, the price of East India cotton at Liverpool varied from 3⅛*d.* to 5⅜*d.* per lb. At a time when the price ranged from 3⅛*d.* to 5¼*d.*, that of United States "uplands," of similar general quality, ranged from 4¾*d.* to 7¼*d.* The reason for this difference was, that the East India cotton was so dirty that 16 oz. of fibre would only yield 12 oz. of yarn; whereas an equal weight of "upland" would yield 13⅛ oz. of yarn. The most recent estimate of cotton supply in India is perhaps that which Dr. Forbes Watson communicated to the Society of Arts, in March, 1859: "There is reason to believe that from time immemorial the cotton plant has been grown in all parts of India, and has always afforded suitable covering for the people of that country; not only does it serve for clothing, but it answers all the several purposes for which flax, wool, hemp, and hair are employed in this country. It may be, indeed, impossible to state the exact quantity per annum thus consumed; it has been variously estimated at from 5 lb. to 20 lb. per head for the whole population. If we assume 12 lb. as likely to be near the mark, we shall find that the present population of India, calculated at 180,000,000, requires annually 2,160,000,000 lb.; and if we further adopt Dr. Royle's average of 100 lb. as the yield of native cotton per acre, we shall find that there cannot be less than 21,600,000 acres under cotton culture, exclusive of that which supplies the present export of raw cotton. These on an average of the last three years amounted to 272,000,000 lb. (including the cotton sent to China and all other places as well as to Britain); and this again divided by 100, will add about 2,700,000 acres to the former quantity. The total quantity of cotton grown in India, according to the above calculation, will consequently amount to upwards of 2,432,000,000 lb., and demand for its culture certainly not less than 24,000,000 acres."

In seeking for the causes of the limited supply to England, and of the bad reputation of East India cotton, with a view to the adoption of remedial measures, the best authorities have drawn attention to five circumstances, all of them very important. We will present the reasonings thereon in a condensed form. 1. *Careless Cultivation.* The cotton-growers of India are very poor and very ignorant. They have no capital to rest upon; no English manufacturers at hand to incite them; no good apparatus for cleaning and pressing cotton; no protection from the roguery and oppression of the native dealers, to whom they sell. Dr. Royle recommended, as a wholesome stimulus, the settlement in the cotton-districts of Europeans, or their properly instructed agents. The duty of these persons would be, to encourage the natives to grow their cotton with more care, unmixed with other and injurious crops; to teach how to pick it as cleanly as possible off the boughs; and to separate the seeds by the best machines obtainable. Or the agent might be instructed to purchase the seed cotton (in the rough state, just as picked from the bush), and clean it himself on the spot. Dr. Royle, a most competent authority, urged that a small amount of money spent in this way would be immensely beneficial, both to India and to England. 2. *Deficient Irrigation.* In the East Indies there is seldom more than 100 lbs. of cotton produced per acre, against 400 lbs. or upwards in the United States. This deficiency is mainly due to imperfect irrigation. The climate exhibits many rapid extremes of heat and cold, wet and dry; and there are few of the cotton-fields which do not suffer, either from too much or too little moisture. What is urgently needed is, draining of the wet land, and especially irrigation of the dry. There is a general opinion that the Indian government would find it profitable to execute works of irrigation, since it would greatly increase the revenue derived from land-tax—the principal fiscal resource in India. Much has been done in this direction within the last few years; and much more would have been done but for the recent excessive demands of the war-department, which have exhausted the exchequer. This interruption of useful public works is much to be regretted; for wherever irrigation works have been constructed the benefit has been great, both financially and morally. A table compiled by Colonel Cotton enumerated thirty-nine different works of irrigation which have been constructed in the Madras presidency during fourteen years, at an expense of 54,000*l.*; which have resulted in a total increase of revenue (after deducting disbursements for repairs) to the amount of 70 per cent. per annum on the original outlay. The Jumna and Ganges irrigation canals have in like manner been eminently useful. 3. *Want of Roads.* The mode of bringing the bales of cotton from the fields to the shipping ports is most tedious and expensive, owing to the deficiency in good roads and means of conveyance. Ox teams and clumsy vehicles are, at present, almost the only available means. General Briggs, in evidence given before the Cotton Supply Committee in 1848, said: "In the absence of a defined and good road, a drove of several hundred head of cattle requires to be constantly watched, and prevented from straying on the march; and this leads to the necessity of travelling by day in hot weather, when the thermometer is seldom less than 100° Fahr. These droves are seldom so few as 100, and often exceed 1000. Every morning after breakfast each ox has to be loaded, and before this operation is over the sun is already high above the horizon. The cattle have then to proceed at the slow rate of two miles an hour, and seldom perform a journey of more than eight or nine miles a day. The herd generally halts one day in seven. If the caravan is overtaken by rain, the cotton, becoming saturated with moisture, is so heavy as to prevent its transport on the cattle; and the roads, if lying through the [wet] ground, are so deep that men even sink above their ankles at every step, and cattle to their knees. It may be easily supposed that under such a calamity, the merchant and the carrier are both ruined." The mode of shipping cotton at Baroach will illustrate one stage in this very clumsy arrangement. The bales are first rolled down to the verge of the muddy shore, into which they sometimes plunge; each bale is then lifted on the shoulders of six men, who stagger up to their knees, or even up to the waist, in mud, to the boat which is to convey the cotton to the ship. Great results will follow from the present construction of main trunk lines of railway through the heart of India; but there must be good roads made from these railways to the sea, and good quays at the shipping ports, before the difficulties of transit can be overcome. 4. *Tenure of Land.* Enterprising and monied cotton-growers are deterred from speculating in India by the unsatisfactory nature of the land-tenure. The government is the sole owner of the soil. Estates are held conventionally, by a sort of tenant right. The cultivators, who we have said are poor, have little inducement to extend their operations, because they fear that any surplus would go to the government in the shape of increased land-tax; the fear may not be well-founded, but it certainly prevails to a large extent among the natives. What seems to be wanted is, the introduction of freehold, copyhold, or leasehold tenures, to give the cultivator both a pride and a profit in an improved mode of husbandry. Mr. Ellison * remarks: "If the East India Company would dispose of their lands, either in perpetuity or for long periods of time, there is no doubt that not only native but English capitalists would be found in plenty to invest their money in the same. The effect of such a proceeding would be, not only an opening up of the resources of India, but it would also cause a portion of the tide of emigration to be turned in that direction. British energy and enterprise would then take the place of Indian indifference and lassitude, and soon double the present extent of our commerce with Hindostan." 5. *Apathy of Manufacturers.* So long as the English spinners and weavers can obtain fair profits for their cotton goods, they care not whence the supply comes; and thus it has been found extremely difficult to bring them to act upon any one common plan to improve and extend the sources of supply. When, on the other hand, profits are low, the manufacturers become alarmed, and blame the government, with or without reason. Until the year 1829, the supply kept ahead of the consumption. In the next six years the demand exceeded the supply, lessening the stock in hand at Liverpool from forty weeks' consumption in 1829, to fifteen weeks' consumption in 1835. After this, owing to the encouragement afforded by high prices, the supply gained on the demand for ten years, bringing the reserve stock in 1845 up to thirty-nine weeks' consumption. Then consumption began again to get ahead of supply, and the Lancashire manufacturers were uneasy. They appealed to the East India Company, urging them to encourage the cotton cultivation in India. Sir James Hogg, on the part of the company, recapitulated what had been done, and recommended the manufacturers to send out a competent agent to the East Indies, to examine into the whole question, and see how far and in what way improvements might best be wrought.

---

* 'Handbook of the Cotton Trade,' 1858—the most recent and valuable work on this subject, compiled from authentic official documents, English and American. We have much pleasure in acknowledging our obligations to Mr. Ellison's volume.

What was done in this matter, we shall see presently, in connection with the Cotton Supply Association.

Egyptian Cotton.—Until about thirty years ago, Egypt produced cotton only in small quantities; but the introduction of good seed and improved methods of culture by the energetic pacha, Mohamet Ali, led to a marked advance. England first imported cotton from Egypt in 1823. In 1855, Mr. Clegg, from inquiries made at Alexandria, computed that there were 60,000,000 lbs. of cotton grown annually. England takes far more than half the produce, the next best customers being France and Austria. The small excess above the quantities so exported is worked up in the cotton mills of Egypt.

North African Cotton.—It was in the year 1850 that the French government first began to direct attention to the cultivation of cotton in Algeria. A portion of the coast was found to possess a soil and climate fitted for this plant. In 1855 there were 150 exhibitors of Algerian cotton at the Paris Industrial Exposition. In that year, about 9000 acres of land were under cotton culture. In 1856 and 1857, the produce fell off in quantity, supposed to be owing to a rush of cultivators into the trade who had neither the requisite capital nor skill. There is, however, no reason to doubt that a steady increase of produce will be exhibited in future years, even though it may never reach any important amount. Along the further portion of the African coast, towards the Atlantic, there is not at present cotton grown in a regular way for the European market; but the English manufacturers are endeavouring to encourage it, by sending good seed, and making known better modes of culture; and the sovereigns of Morocco and Tunis seem well disposed to second these endeavours.

West African Cotton.—Considering the nature of the climate and the abundance of labour at the west, or rather north-west, coast of Africa, there is every reason to think that cotton might be extensively grown in that region. Mr. Clegg, on the part of the Lancashire manufacturers, in conjunction with the Church Missionary Society, has brought this subject under the notice of the authorities at Sierra Leone, Lagos, Fernando Po, Liberia, and the interior. In the year 1852 there were 1810 lbs. of cotton brought to Liverpool from that region; it gradually rose, until the first four months of 1858 exhibited an import of 96,000 lbs. Mr. Clegg's own account of his operations, communicated to the Society of Arts in December, 1858, is full of interest: "Some ten years ago, seeing the importance of the subject, he thought he would, as an individual, see if he could not get cotton from somewhere else than America. He turned his attention to Africa; and he asked the Church Missionary Society, of which he was a member, to select for him suitable agents, to whom he could entrust money for the purchase of cotton from the African natives. He made arrangements always to have money on the spot, in the hands of the agents; and his instructions were, that they should purchase the cotton of the natives in however small parcels it might be brought to them; if only half a pound had been plucked from the plants, they were to buy it. The consequence was, that in a short time the women brought small quantities of cotton to the stations: this was communicated to their neighbours; and in a little while afterwards seed was planted, and the cotton growth became more and more plentiful. He sent out a number of cotton gins, which the natives soon learned to use. He also erected a store, and placed a large number of gins in it. The natives brought the cotton in pods and in seed, and they learned to clean it; and after using a gin sufficiently long to pay the expense of it, they shouldered the implement and carried it off as their own property, to be used hereafter in dressing the cotton they brought for sale. He had introduced three young African natives into his mill at Manchester, where they had been taught the use of machinery generally; and they had been sent back to their own country, to carry out the preparation of cotton upon a larger scale." Mr. Clegg estimates that West African cotton can be sold at Liverpool for 4¼*d.* per lb., made up thus:—

	d.
4 lb. of cotton in the seed, at ½*d.*	2
Cleaning it into 1 lb. of good fibre	¼
Packing and canvas	¼
Carriage to port and shipping	¼
Freight to England	1
Charges at Liverpool	¼
	4¼

If the cotton were of fairly good quality, and moderately clean, it would meet with eager purchasers at anything near this price.

South African Cotton.—Whether the region around the Cape of Good Hope could produce cotton of a quality and price that would compete with that of America in the English market, is a problem not yet answered; there is not at present an organisation sufficient for ensuring a due and steady supply of labour. Attention is, however, at present directed to a part of Africa north of the Cape, scarcely known to Europe until Dr. Livingstone visited it. This skilful and energetic traveller, in passing through the country of Angola, saw the native women spinning cotton with spindle and distaff. "The cotton was brought to the market for sale, and I bought a pound for a penny; this was the price demanded, and probably double what they ask from each other. We saw cotton growing luxuriantly all around the market-place from seed dropped accidentally. This is seen also about the native huts; and so far as I could learn, it was the American cotton so influenced as to be perennial." He found an abundance of willing labourers; but no roads from the cotton-fields to the sea-coast. "I found the people were anxious to engage in commerce with us; but they had no roads, nor pathways down to the coast; and although 100,000*l.* worth was annually exported in ivory, bees'-wax, and palm-oil, yet every ounce thus procured was taken down to the coast on the heads and shoulders of men." M. Canto, Portuguese commandant of Gelanjo Alto, on one occasion said to Livingstone, "If I had possession of a few hundred pounds, I would create a complete revolution in the commerce of this country; I would purchase all the cotton now produced, and certainly next year they would produce much more; and then the third year I could make myself rich with a few hundred pounds." When Dr. Livingstone returned to Africa in 1858, he took with him a few bushels of very fine cotton seed, to encourage the natives to grow cotton fitted for the English market, hoping that roads and other facilities would gradually be obtained. In a debate in the House of Commons on the Slave Trade, on July 12th, 1858, Lord Palmerston expressed himself thus strongly: "I venture to say that your commerce with the (south) western coast of Africa in the article of cotton will, in a few years, prove to be far more valuable than that of any other portion of the world—the United States alone excepted."

Miscellaneous Cotton Districts.—All the remaining cotton-growing districts may be passed over briefly. *Asiatic Turkey* used formerly to be a great source of supply for England; but the portion furnished has now become very small—partly because the inhabitants of Asia Minor and Syria have introduced the cotton manufactures among themselves, and partly because the portion exported goes to France rather than to England. It is believed that, so far as natural capabilities are concerned, the produce in Western Asia might be immense; but to develope this produce would require irrigation, good seed, capital, energy, and skill. *Spain* and *Italy* grow a little cotton, but it is too little to need attention here. *Australia* has been examined in certain places, with a view to ascertain whether the soil and climate are suited for cotton culture. There is a district, measuring about 300 miles by 100, near Moreton Bay, which is believed to possess many of the requisite qualities; but the scarcity of cheap labour is at present an insuperable difficulty.

To what extent the several countries of the world *consume* the cotton thus grown, is a subject treated in a separate article [COTTON TRADE AND CONSUMPTION]; we have here purposely confined our attention almost exclusively to growth and supply.

(*First and Second Annual Reports of the Cotton Supply Association,* 1858 and 1859; Ellison, *Handbook of the Cotton Trade,* 1858; Royle, *Culture of Cotton in India;* Mackay, *Reports of Cotton Culture in Western India;* Livingstone's *Travels in Africa; Jury Reports on the Great Exhibitions of London and Paris in* 1851 *and* 1855; M'Culloch's *Commercial Dictionary,* last edition; *Liverpool and Manchester Trade Circulars; New York and New Orleans Trade Circulars;* Baynes' and Bazley's *Lectures on the Cotton Manufactures; Consular Reports on the Trade of Foreign Countries; Board of Trade Tables: Parliamentary Papers; United States' Statistical Tables.*)

COTTON MANUFACTURE. We now arrive at the second of the three divisions into which it has been deemed desirable to group the information concerning cotton; namely, the manufacturing processes, in their history and their practice.

The use of cotton as a material for the production of woven fabrics, was known in India and China for many centuries before its introduction into Europe. The earliest mention of cotton by the Greek writers is by Herodotus (iii. 106) in his brief notice of the usages of the Indi: he calls it (iii. 47) by the significant name of tree-wool (*εἴριον ἀπὸ ξύλου*), apparently not being acquainted with the native name. In the reign of Amasis, B.C. 563–525, cotton was known in Egypt; but it must have been imported, for there is no reason for supposing it was then grown in Egypt. Cotton cloths were, according to Arrian, among the articles which the Romans received from India; and there is no doubt the manufacture had been carried on in many parts of Asia, long before any extant notice of that quarter of the world being visited by Europeans. The perfection to which the weaving of cotton had then been brought by the natives of many parts of India, notwithstanding their rude and imperfect implements, attests at once their patience and ingenuity. In China, this manufacture is supposed not to have existed at all before the beginning of the sixth century of the Christian era. The cotton plant was indeed known in that country at a much earlier period, but continued till then to be cultivated only as a garden shrub, and was not indeed propagated on a large scale until the eleventh century; at the present time nearly all the inhabitants of that populous empire are clothed in cotton cloths of home manufacture, made from cotton brought in part from India, but mostly of home growth.

Before the discovery of the passage to India round the Cape of Good Hope, cotton wool is said to have been spun and woven in some of the Italian states, the traders of which were the channels through which the cotton fabrics of India were distributed to the different countries of Europe. Becoming thus acquainted with these goods, and having near at hand the raw material of which they were formed, it was natural that they should apply to the production of similar goods the manufacturing skill they had long possessed.

Baines has shown ('History of the Cotton Manufacture,') that the cotton plant was extensively cultivated, and its produce manufactured, by the Mohammedan possessors of Spain in the tenth century. This branch of industry flourished long in that country. In the thirteenth century the cotton manufacturers formed one of the incorporated companies of Barcelona, in which city two streets received names which point them out as the quarter in which the manufacturers resided. The cloths made were mostly of coarse texture, and a considerable quantity was used as sail-cloth. The name *fustians*, from the Spanish word *fuste*, signifying "substance," was borrowed from the Spanish weavers, and is still used to denote a strong fabric made of cotton. The intercourse between the Mohammedan possessors of Spain and the Christian inhabitants of other European countries was so small, owing to religious prejudice, that the arts which long flourished among the former, did not extend themselves to the latter; the traffic of Andalusia was all carried on with Africa and the East.

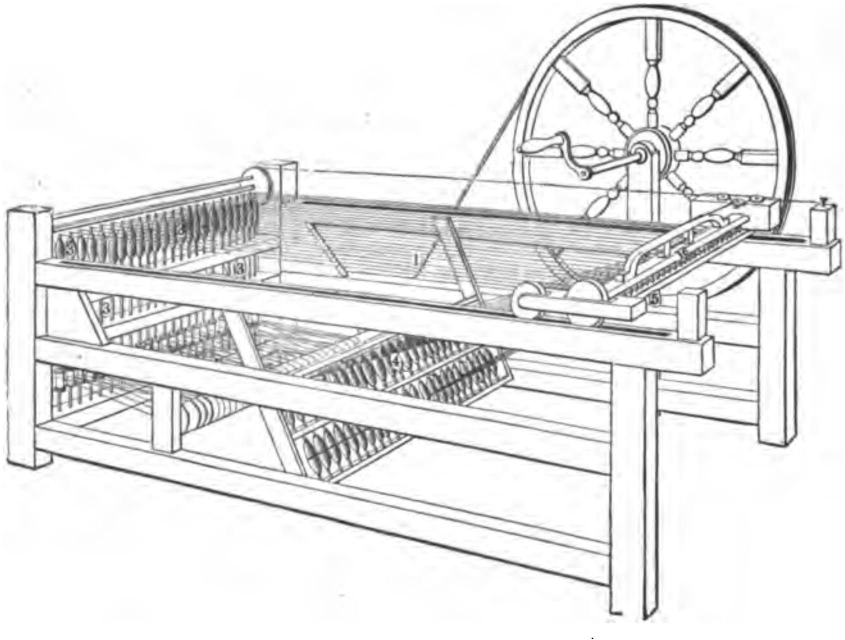
From Italy the cotton manufacture made its way to the Netherlands, and about the end of the sixteenth or the beginning of the seventeenth century was brought thence to England by protestant refugees. Lewis Roberts, in 'The Treasure of Traffic,' published in 1641, makes the earliest mention extant of the manufacture in England. He says, "The town of Manchester buys cotton wool from London that comes from Cyprus and Smyrna, and works the same into fustians, vermilions, and dimities."

There is abundant evidence to show that in the beginning of the sixteenth century, and probably before that time, cotton was cultivated and converted into clothing in most of the countries occupying the southern shores of the Mediterranean. The European conquerors of Mexico in their first invasion of that country found in use native manufactures of cotton, both unmixed and mixed with the fine hair of rabbits and hares. Some of these fabrics were sent by Cortes to Spain as presents to the Emperor Charles V. Cotton was cultivated and manufactured at an equally early period by different nations on the coast of Guinea, and it is stated by Macpherson in his 'Annals of Commerce,' that cotton cloths were imported into London in 1590, from the Bight of Benin.

It would be difficult to trace the introduction of the cotton manufacture in the different countries of Europe where it is now established but some notice of its recent progress and present state therein will be found in the next following article.

In England, previous to the introduction of the inventions of Arkwright, this manufacture was of small importance, as is evident from the quantities of the raw material then brought into the country. Arkwright's first patent for the mode of spinning by rollers was taken out in 1769; and between the years 1776 and 1780 the average annual consumption barely reached seven millions of pounds. The system under which this manufacture was long carried on was very different from that which is now pursued. It was the custom for the weavers who were dispersed in cottages throughout the district to purchase the material with which they worked, and having converted it into cloths, to carry their wares to market and sell them on their own account to the dealers; but about 1760, the merchants of Manchester began to employ the weavers—furnishing them with yarn for warp, and with raw cotton to be spun by the weaver's family into weft, and paying a fixed price for the labour bestowed in weaving.

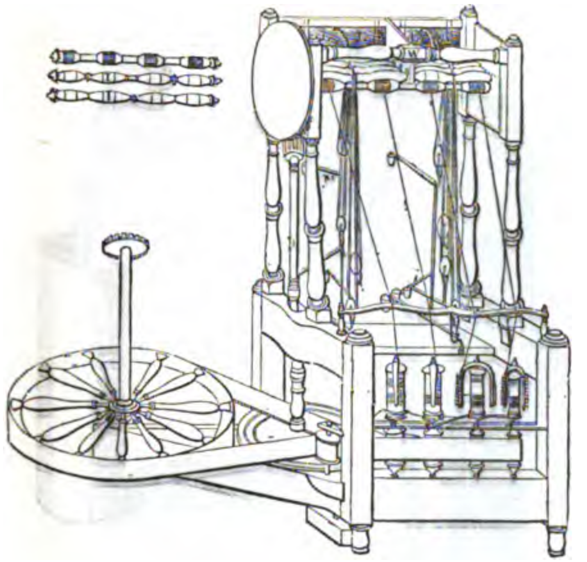
The application of machinery to the preparation and spinning of raw cotton for weft preceded by some years the inventions of Arkwright. In the year 1760, or soon after, a carding engine not very different from that now used was contrived by James Hargreaves, an illiterate weaver, residing near Church in Lancashire; and in 1767 the *spinning-jenny* was invented by the same person. This machine, as at first formed, contained eight spindles, which were made to revolve by means of bands from a horizontal wheel. Subsequent improvements increased the power of the spinning-jenny to eighty spindles, and the wheel was placed vertically, as in the annexed cut:—where the rovings (1), clasped and drawn by the frame (5), are transferred in an attenuated state from the spindles (3) to (4). The saving of labour which it thus occasioned produced considerable alarm among those persons who had employed the old mode of spinning; and a party of them broke into Hargreaves' house and destroyed his machine. The great advantage of the invention was so apparent, however, that it was soon again brought into use, and nearly superseded the employment of the old spinning-wheel. A second rising then took place of the persons whose labour was thus superseded by it; they went through the country destroying, wherever they could find them, both carding and spinning machines, by which means the manufacture was for a time driven away from Lancashire to Nottingham.



[Hargreaves' Spinning Jenny.]

The cotton-yarn produced both by the common spinning wheel and the spinning-jenny, though suitable for weft or cross-threads, could not be made sufficiently strong to be used as warp or long-threads; and, therefore, linen-yarn was used for the last-named purpose. It was not until Arkwright's spinning frame was brought into successful operation that this disadvantage was overcome. Yarn spun with Hargreaves' jenny continued for some time to be used for weft. At first, the manufacturers of cloths composed of cotton only were subject to much annoyance from the determination of the revenue officers to charge them with double the duty paid upon calicoes woven with linen warp and printed for exportation; and also by prohibiting their use at home. With some difficulty an act of parliament was obtained for removing these obstacles to the development of the manufacture, which from that time was prosecuted with a great and continually accelerated rate of increase.

The earliest attempts at producing the finer cotton goods called *muslins* were made about the year 1780; but without much success, although India-spun yarn was substituted as weft for that produced by the spinning-jenny: the greatest degree of fineness to which yarn spun with Arkwright's frame had then been brought, was eighty hanks to the pound, and even this degree was not attainable by means of the jenny. This disadvantage was overcome by the invention of Samuel Crompton's machine, which came into general use about the year 1786, and which, partaking of the nature of both Hargreaves' and Arkwright's machines, was aptly called the *mule-jenny*. By means of this piece of mechanism, yarns were produced of a much greater fineness than had before been attained. Crompton's invention was made several years before it could be openly used, because of its interference with the patented invention of Arkwright; but when this patent was annulled, the mule-jenny was brought rapidly and extensively into use. No less than 500,000 pieces of muslin were made at Bolton, Glasgow and Paisley, in 1787, with yarn of British production.



[Arkwright's Original Spinning Frame.]

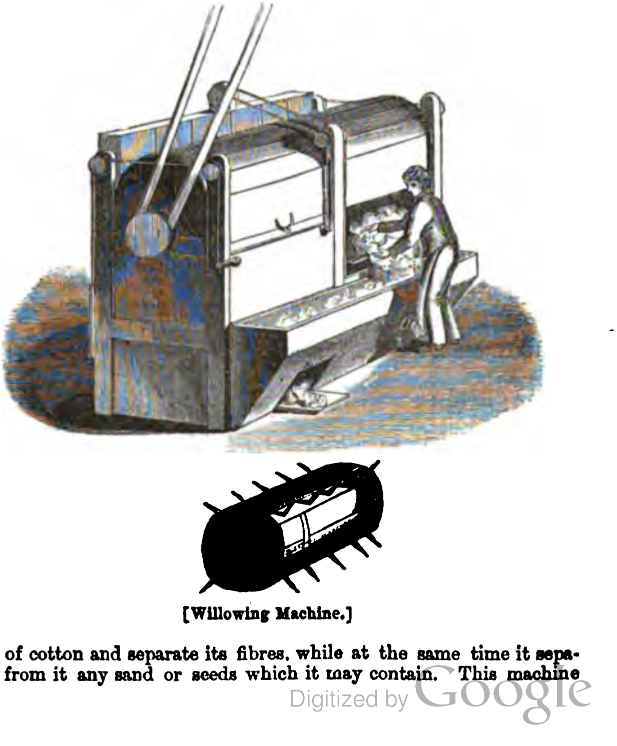
Crompton did not secure to himself the benefit of his invention by taking out a patent; he carried on a spinning and weaving business on a small scale at Bolton, and worked his mule-jenny with his own hands in an attic. In a brief memoir of Crompton, Mr. Kennedy has stated, that about 1802 he, in conjunction with Mr. Lee, set on foot a subscription which amounted to 500*l.*: and that with this fund Crompton was enabled to increase his manufacturing establishment, and to set up several looms for fancy work in Bolton. In 1812 Crompton made a survey of all the cotton manufacturing districts in the kingdom, and ascertained that the number of spindles then at work upon his principle amounted to between four and five millions. The kind friends already named assisted him in making an application to parliament for some reward; and the great merit of his invention having been established before a Committee of the House of Commons, he received a grant of 5000*l.*, which was paid to him in full without any deduction for fees or charges. This money was employed by Crompton in putting his sons into business; but they proved unsuccessful, and he was reduced to poverty. Mr. Kennedy again interfered in his behalf, and raised a second subscription, with the produce of which a life annuity of 63*l.* was purchased. Crompton lived only two years to enjoy this small provision. The first mule-jennies consisted of not more than thirty spindles each, but the number has been progressively increased, and they now frequently contain from 600 to 1000 spindles each, or even a still greater number. The next great improvement in the construction of this machine was effected by Messrs. Sharp, Roberts & Co., machinists of Manchester. Their machines, which are called *self-acting mules*, do not require the manual aid of a spinner, the only attendance necessary being that of children, called piecers, who join such threads as may be accidentally broken. Self-acting mules were contrived at different times by Mr. William Strutt of Derby, Mr. Kelly of Lanark, Mr. De Jongh of Warrington, and others; but none of these were brought successfully into use, owing, no doubt, in some measure, to the inferior skill of the machine makers of those days.

Another event which contributed to the rapid extension of the cotton manufacture, was the successful attempt to weave by means of machinery, made in 1785 by Dr. Cartwright, who secured the invention by patent. In a commercial point of view Dr. Cartwright did not draw any advantage from his power-loom; but in 1809 he obtained from parliament a grant of 10,000*l.* as a reward for his ingenuity. Mr. Monteith, of Pollokshaws, Glasgow, who fitted up 200 power-looms in 1801, was the first person who brought them to profitable use. A great obstacle to their success was presented by the necessity for the frequent stopping of the machine in order to dress the warp. This difficulty was removed in 1804 by the invention of a machine for dressing the whole of the warp before it is placed in the loom, which was made the subject of a patent by Mr. Radcliffe, the inventor. In the use of this machine the warp in its progress to the weaving beam is passed through a dressing of hot starch: it is then compressed between rollers to free it from the superfluous quantity of starch taken up; and afterwards, in order to dry it, the warp is drawn over a succession of cylinders heated by passing steam through them. By this means the weaver is relieved from the necessity of stopping from his weaving to dress the warp.

The machines and apparatus of recent introduction, connected with the cotton manufacture, almost countless as they are in number, are rather extensions and improvements of systems already known, than inventions partaking of the capital importance of those of Arkwright, Hargreaves, Crompton, Cartwright, Radcliffe, and Roberts. Instead of attempting the hopeless task of describing the various modern inventions, we shall proceed at once to a description of the processes in their ordinary routine. The cotton fibres have to be spun into yarn or thread before they can be woven into calico, fustian, muslin, or other textile material; and this spinning is the most important part of the whole operation. Nevertheless it can be effected, in a slow way, with few and rude implements. Among all the ancient mechanical arts there were few so simple as that of converting the downy filaments of the cotton plant into a continuous thread according to the methods generally used before the time of Hargreaves and Arkwright. The same primitive methods are still employed in eastern countries. There are, on the other hand, few processes for the performance of which the inventive powers of man have since that period been more taxed, in this country and during this age of invention, than for the cheap and perfect production of cotton twist and yarn. The use of the spindle and distaff was superseded in England by the spinning-wheel, in or soon after the reign of Henry VIII. The next improvements in this useful art were those of Hargreaves and Arkwright; which were followed by the whole train of novelties just adverted to.

One of the first processes in a cotton mill is that of mixing the fibres. Owing to the great variety generally found in the quality of different bags of cotton, which would otherwise occasion a corresponding difference in the quality of the yarn produced, the contents of several bags are mixed together in a heap. This is done by spreading out the contents of each bag in a horizontal layer of uniform thickness, the contents of the several bags forming separate layers and resting one upon the other, so that the number of layers corresponds to the number of bags. In making this heap, which is called a *bing* or *bunker*, the several layers are trampled or pressed together somewhat in the manner of building a hay-stack. The cotton of which the bing is composed is then torn down by a rake from top to bottom. It is evident that in its progress a portion of each horizontal layer will be brought away, and that thus, if the work be skilfully done, the contents of the different bags must be collected together in a mass of uniform quality. It is customary to mix in this manner different descriptions of raw cotton for the production of various qualities of yarn; and some skill on the part of the manufacturer is called for in order to produce a mass that will answer the intended purpose at the least possible cost. The practice of different spinners varies much in this respect, but it is considered proper as a general rule to mix together only such qualities as are similar in the length of their staple. The waste cotton produced in the previous operations of the mill is mixed in the bing in certain proportions for making the lower or coarser qualities of yarn. For the higher or finer numbers, and for twist which is used for warp, finer qualities of cotton are required than for low numbers or for weft. It may here be mentioned that in the technical language of the trade, 'high numbers,' meaning fine yarns, denote a great number of hanks to the pound; while 'low numbers,' meaning coarse yarns, denote a smaller number of hanks to the pound.

When the cotton has been mixed, the machine next employed is usually the *Scutching or Willowing Machine*. This is used to open the locks of cotton and separate its fibres, while at the same time it separates from it any sand or seeds which it may contain. This machine



[Willowing Machine.]

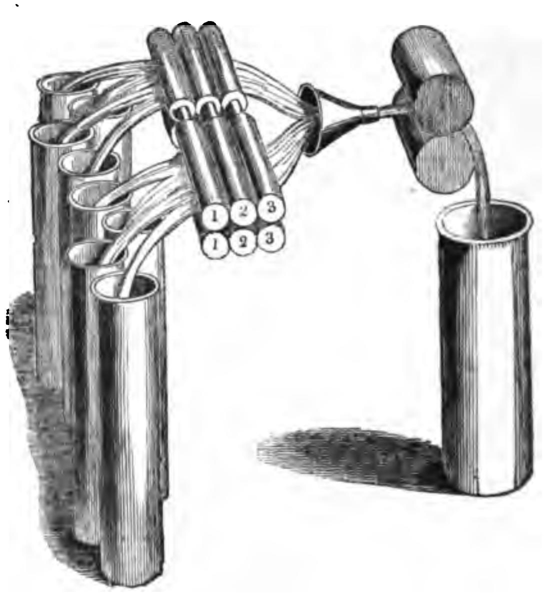
consists of feeding-rollers made of wood and placed at a short distance from each other; the cotton, while passing slowly between the rollers, is struck by a set of beaters made to revolve from 1000 to 2000 times in a minute. The cotton is passed through two such sets of rollers, and subjected to two sets of beaters. It is then taken to the *Spreading Machine*, the use of which is to spread a given weight of cleaned cotton into a given length and breadth, in order to its being presented of uniform thickness to the next process. The spreading machine is, however, not universally used; where the heavier quality of yarn is spun it answers sufficiently well, and effects an adequate saving of labour; but for fine yarns, where the greatest precision is required in order to produce regularity in the size of the yarn, machine-spreading does not answer so well as hand-spreading. The cotton is weighed very accurately before it is put into the spreading-machine, and when perfectly spread is called a *feed*, the thickness of which will of course be regulated by the weight of cotton supplied to the machine. This operation is repeated continuously, so that an unbroken sheet of cotton passes through the machine and is wound on a wooden roller. In this form the cotton is called a *breaker lap*.

Up to this stage the fibres of the cotton cross each other in every direction. The *Carding Engine* then comes into requisition, to disentangle them, to draw them out, and to lay them parallel to each other. Properly speaking, this is the first operation of spinning—the previous processes being used only to open and clean the cotton. The card is a species of brush made of short wires passed through a sheet of leather and pointing all in one direction. In the early period of cotton-spinning in this country, these cards were nailed on small pieces of board with handles, and two of them were used together, one held in each hand. The first improvement made in this implement was effected about 1760, by James Hargreaves, the same ingenious man who, a few years later, invented the spinning-jenny. This improvement in the cards consisted in having one of them greatly increased in size, and fixed; this was called the stock, and the other was suspended by a cord working in a pulley, fixed to the roof of the work-shop; the effect of this arrangement was that two or more cards could be applied to the same stock. This modification was immediately followed by the greater improvement of *cylinder cards*; the father of the first Sir Robert Peel set up a machine of the kind at Blackburn in 1762, with the assistance of Hargreaves. The inventor of cylinder cards is not known with certainty; but Mr. Baines ascribes the invention to Lewis Paul, who took out a patent in 1748 for improvements in carding. The carding engine, which was the natural result of the invention of cylinder-cards, consists of a horizontal cylinder covered in its entire circumference with narrow fillet cards wound spirally round the cylinder, leaving an intervening space between the several spiral lines thus described. Over the cylinder is a concave frame, the interior surface of which is lined with cards, and the form of which corresponds to that of the cylinder. When the cylinder is made to revolve, the cards on it and on the frame act against each other, by which means the fibres of cotton are disentangled and properly arranged, as already mentioned. The cylinders, which are usually about 3 feet in diameter and 3 feet long, are made to revolve at the rate of 100 to 150 turns in a minute.

The cotton, in the form already described as a breaker lap, is led into the carding machine by a slow motion through feeding-rollers, little more than one inch in diameter. The fibres of the cotton are then immediately engaged by the wires of the main cylinder, and after being by their means properly arranged, are thrown off by its velocity to a second cylinder called a *doffer*.

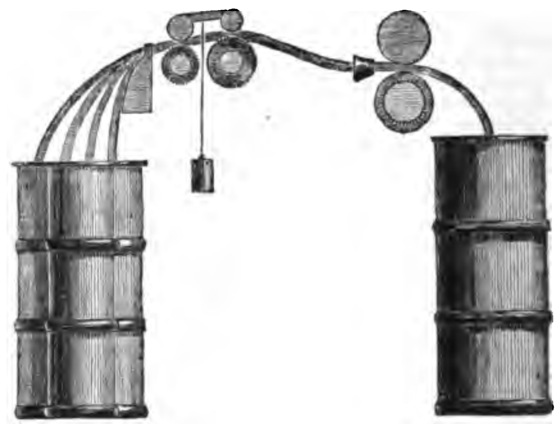
When cylinder-cards were first used, hand-cards were employed to take off the cotton. Various contrivances were at different times adopted for improving this part of the process; until at length Arkwright contrived for the purpose a plate of metal toothed at the edge like a comb, which, instead of revolving as the former contrivances had done, was, by means of a crank, made to move rapidly in a perpendicular direction, and with slight but reiterated strokes on the teeth of the cards detached the cotton from them in a uniform fleece. This fleece is made to undergo compression on its passage to a roller, from which it is delivered in the form of a thick but soft thread, called a *card-end*, or *sliver*, into a tin can. The duration of the carding process is made to depend upon the quality of the cotton under preparation; if the fibres are short and coarse, the carding should be quickly performed, not indeed by accelerating the speed of the cylinders, but by taking the cotton faster off the cards.

The next operation is called *drawing*, and the machine by means of which it is performed is called the *Drawing-frame*. The object of this drawing is to complete what has been begun by the carding engine, namely, the arranging of the fibres of cotton longitudinally, in a uniform and parallel direction, and to remedy all existing inequalities in the thickness of the sliver. The drawing-frame acts upon the same principle as Arkwright's spinning-frame, two or three sets of rollers being employed moving with unequal velocities. In its passage through the first pair (1, 1) the sliver is simply compressed; but being drawn through the second and third pairs (2, 2 and 3, 3) with gradually increasing velocities, it is necessarily drawn out in the same proportion. In repeating this operation, which is called *doubling*, two, three, or a greater number of the drawings are passed through each set of rollers; in the first they are made to coalesce, and in the second are again drawn out. These doubling and drawing processes are repeated very frequently, in order to correct every inequality in the thickness of the cord or sliver; they are of the utmost importance, and if ill or insufficiently performed, the yarn cannot prove of good quality.



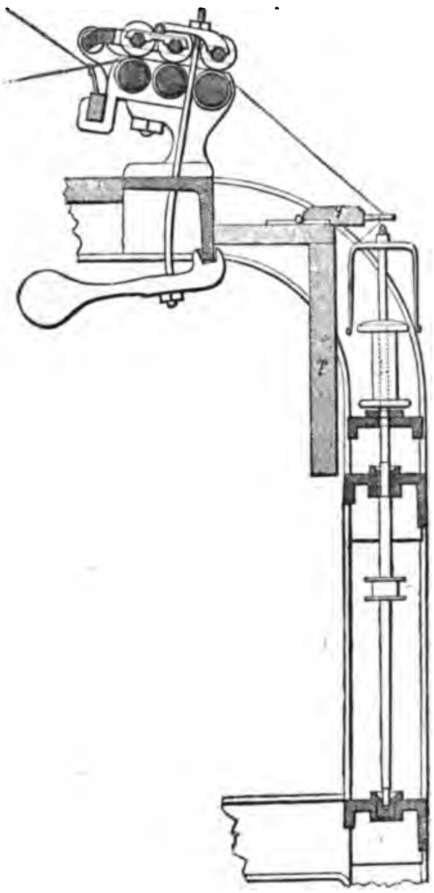
[Drawing Rollers and Cans.]

Roving, the next step in the process, is a continuation of the drawing, with this only difference—that the cord, now called a *rove* or *slub*, being so much reduced in thickness that it will not otherwise hold together, a slight twist is given to it by passing it into a metal can, which, while receiving it, is made to revolve with great velocity. The rove thus slightly twisted, is wound upon bobbins, and is then ready for the spinning-frame. About the year 1817, a machine called a *fly frame* was contrived for preparing rovings for inferior numbers of yarn. Instead of revolving cans, this frame is provided with a series of spindles, each of which is furnished with a flyer; the revolutions of this flyer give the requisite twist to the cord, which is delivered at once to the bobbin fitted loosely on the spindle. The *tube frame*, more recently introduced, is used for preparing yarns of all qualities. Instead of cans, this frame is provided with revolving horizontal cylinders: and by its means a much greater quantity of work can be done in a given time than with the fly frame; the rove which it produces has no twist, and is therefore very tender, and the quantity of waste which it occasions is greater than is otherwise experienced.



[Roving Cans.]

The important process of *Spinning* then comes for notice. The principle of Arkwright's original *Spinning frame* may be briefly described: There were two pairs of rollers; the first pair slowly revolving in contact; and the second pair, at a little distance, revolving with greater velocity. The lower roller of each pair was fluted longitudinally, and the upper one was covered with leather, by which means the two would have a sufficient hold upon the cotton passed between them. The cotton, when passed between the first pair of rollers, had the form of a thick but very soft cord, and was no further altered in its texture than by receiving a slight compression; but as the second pair of rollers moved with many times the velocity of the first, the cotton was drawn out many times smaller than when delivered from the first rollers.

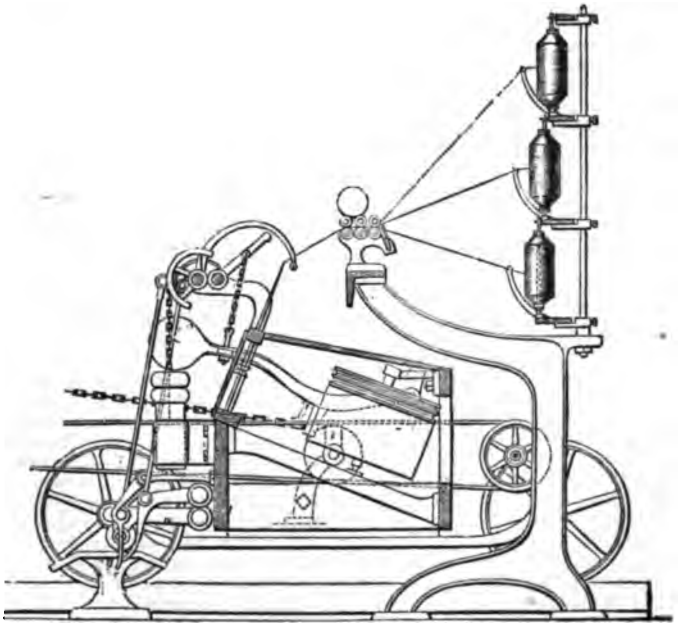


[Throstle spinning.]

The yarn produced by its means received the name of *water-twist*, from the circumstance of the machinery being at first set in motion by water power. The *Throstle frame* is the same in principle as Arkwright's invention; but the movement of the parts is simplified, so that the speed of the machine is increased, and a greater number of spindles may be driven with an equal amount of power; it was introduced about the year 1810. The ***Mule-jenny***, invented by Samuel Crompton, combines the essential principle of Arkwright's frame with the property of stretching possessed by Hargreave's jenny. By means of the mule-jenny, the roving is first drawn and then stretched. The effect of this improvement is to make the yarn finer, and of a more uniform tenuity. When delivered by the rollers, the thread is thicker in some parts than in others; these thicker parts, not being so effectually twisted as the smaller parts, are softer and yield more readily to the stretching power of the mule; and by this means the twist becomes more equable throughout the yarn. Throstle-spinning is seldom employed for higher numbers than forty to fifty hanks to the pound, because smaller yarn would not have strength to bear the drag of the bobbin; but in mule-spinning no bobbin is used, and the yarn is wound or built upon the spindles without subjecting it to any strain. The spindles in this machine are regularly arranged on a carriage, which when put in motion recedes from the rollers with a velocity somewhat greater than that at which the reduced rovings are delivered from them; during this time the yarn is receiving its twist by the rapid revolving of the spindles; when the rollers are made to cease giving out the rovings, the mule-jenny still continues to recede, but with a slower motion, and its spindles to revolve; and thus the stretching is effected. The distance which the spindles recede from the rollers while both are in action is called a *stretch;* this is usually about fifty-four or fifty-six inches: the space through which the mule moves greater than and during the giving out of the rollers, is called the *gaining* of the carriage; and the further space accomplished by the carriage after the rollers are stopped, is called the *second stretch;* during this latter part of their progress, the spindles are made to revolve much more rapidly than before, to save time. When the drawing, stretching, and twisting of the thread are thus accomplished, the mule disengages itself from the parts of the machine by which it has been driven, and then the attendant spinner returns the carriage to the rollers, again to perform its task. While returning to the roller, the thread which has been spun is wound or built on the spindle in a conical form, and is called a *cop*. The mule-jenny is a complex piece of mechanism, and requires to have all its parts very nicely fitted and adjusted.

The *Self-acting mule* contrived by Mr. Roberts, and improved by later inventors, is a beautiful example of automatic mechanism. The carriage of this mule, after having drawn out and stretched and twisted the thread, is returned again to the rollers by mechanical means without the guidance or intervention of any intelligent agent, the only attendance required being that of children to join such threads as may have been accidentally broken in the stretching. This self-acting mule is even more complex in its arrangements than the original machine, and hence great doubts were entertained as to its successful working; but it has triumphed over all difficulties. Its advantages as regards economy, and rendering the manufacturer independent of a class of workmen who frequently proved refractory, are so great, as to have led to a general adoption of the machine.

If the yarn spun with the mule-jenny be intended for use as woft in the factory where it is produced, the cops are at once applied to the shuttle; but when intended for warp, and generally when exported, the yarn is reeled into hanks each 840 yards in length, for performing which operation a *Self-acting reel* has been contrived. This process is



[Carriage of Self-acting Spinning Mule.]*

attended by young women. The diameter of the reel is 4½ feet; when it has performed 80 revolutions, a *lay* is formed measuring 120 yards, and seven of these lays make up a hank. Each hank is separately tied round with a thread, and weighed to ascertain its fineness; the different sizes are then put by themselves, and separately packed in paper bundles of either five or ten pounds weight.

Fine yarns are usually singed, in order to remove their loose downy fibres and to give them smoothness. This is accomplished by subjecting the thread to the action of a series of coal-gas flames, through or over which it is several times passed with a degree of quickness sufficient to prevent burning.

Cotton *thread*, for sewing, is made by laying together two or more yarns of equal quality, and twisting them; for which purpose distinct machinery is employed. Previous to the doubling and twisting, the yarn is passed through a trough, containing a thin solution of starch; the twist is given in an opposite direction to that applied by the spinning machine, causing the thread to resemble in this respect organzine silk.

Scarcely any operation in a cotton mill, we thus see, is carried forward without the intervention of a machine, by which the work is done with greater precision, and also with greater celerity, and consequently greater economy. The packing of the hanks of yarn into bundles is the work of a *bundle press*, by means of which the hanks are pressed into a small compass, the power of the machine enabling females to exert sufficient strength for the purpose. Even here, however, steam power is sometimes employed.

The degree in which the inventions that have here been noticed have reduced the expenses attending this branch of manufacture is great almost beyond belief. One pound of the yarn known as No. 100 was, in the year 1786, worth 38*s.*; in 1791, it was 29*s.* 9*d.*; in 1795, 19*s.*; in 1799, 10*s.* 9*d.*; in 1807, 6*s.* 9*d*; in 1832, 2*s.* 11*d.*; and in recent years it has been still lower. The average waste in spinning cotton is considered to be about 1½ oz. per pound; it is very much higher in fine yarns than in coarse, and this is one reason for the increased price of the former. Mr. Ainsworth, an eminent Lancashire manufacturer, has recently pointed out the ratio which raw material bears to labour, in four varieties of textile manufacture, thus:—

				For finished Goods.
1 lb. wool for flannel costs	1*s.* 6*d.*	+ 1*s.* 7*d.*	for wages	= 3*s.* 1*d.*
1 lb. wool, for coarse cloth costs	1*s.* 2*d.*	+ 4*s.* 0*d.*	„	= 5*s.* 2*d.*
1 lb. flax for shirting costs	0*s.* 10*d.*	+ 1*s.* 6*d.*	„	= 2*s.* 4*d.*
1 lb. cotton for sheeting costs	0*s.* 6*d.*	+ 0*s.* 6*d.*	„	= 1*s.* 0*d.*

The mechanical inventions relating to the various processes of cotton manufacture, patented or otherwise, are, as has been already implied, numerous almost beyond belief. The records of the Patent Office, now placed in such admirable order under the superintendence of Mr. Bennett Woodcroft, show this conclusively. It is not possible to give the number of patents with accuracy, because some of them relate to wool and flax as well as to cotton; but it is pretty evident that the last-named fibre occupies the prominent place. Down to the close of the year 1858 there had, since the commencement of the patent system, been 256 patents granted relating more or less to the cleaning, spinning, separating, scutching, and batting of fibrous materials; 82 containing provisions relating to the carding, combing, drawing, doubling, and roving of the materials thus prepared; and the enormous number of 1376 touching in a greater or less degree the processes and apparatus for spinning, twisting, and thread-making. It must not, as just stated, be understood that all these related to cottons; nor that there were 2457 separate patents relating to textile materials, seeing that some of the patents comprise within themselves the characteristics of all three lists, or of two out of the three; but it is quite certain that the patents relating strictly to the cotton manufacture are many hundreds in number. All these are irrespective of weaving processes, which have been made the subjects of a distinct series of patents.

As the weaving of cotton does not differ much in principle from that of linen, woollen, and silk, it will suffice to describe them all in one article. [Weaving.] The statistics connected with the manufactured products of cotton-mills will come most suitably into the subjoined article [Cotton Trade and Consumption], as will likewise a brief notice of the cotton manufacture in foreign countries.

It would not be right to close this article without a few lines descriptive of those important establishments, the cotton-mills of the north—those extraordinary centres of industry, which have stamped a character on the counties containing them. It is computed that, in 1859, if we draw a circle of thirty miles radius around Manchester, that circle will be found to contain more inhabitants than a circle of similar size having London in its centre. Liverpool, the great port for landing raw cotton and for shipping manufactured cotton goods, is just within the circle: Manchester, the cotton metropolis, is by the terms of the argument in the centre of the circle; while other parts of the area include the great towns of Preston, Chorley, Blackburn, Accrington, Clitheroe, Burnley, Haslingden, Bacup, Rawtenstall, Bolton, Bury, Middleton, Oldham, Ashton, Staleybridge, Dukinfield, Hyde, Glossop, Mottram, Stockport, &c.—all of which contain immense establishments for spinning, weaving, bleaching, or printing cotton; and there are so many similar establishments occupying the valleys and roads between those towns, that the whole area may be regarded as one large workshop. The same may be said, in a smaller degree, of the district around Glasgow. Some of the mills spin cotton only, some weave it only, while some spin and weave. Some kinds of cotton goods are more largely made than others in particular towns; fine muslins in one, shirting calicoes in another, fustians in a third, and so on. Most of the spinning and weaving mills are buildings of vast size, speckled over with windows on every side. Some of them have six or seven hundred windows each, which give light to seven or eight stories or ranges of rooms. In those of improved construction, there is apparatus for lifting the workpeople, or some of them, from story to story, thereby lessening the fatigue and the consumption of time involved in ascending staircases. As one part of the perfect system which has gradually become organised in this trade, it is customary to haul up the bales of cotton to the highest story of the building, and then gradually lower the material from story to story until it leaves the bottom range in a finished state; thus the opening, the mixing, the scutching, the carding, the drawing, the roving, and the spinning, follow in their proper order, in rooms occupying different heights in the range of building. If it be a weaving as well as a spinning mill, the weaving machines or power-looms, sometimes fifteen or eighteen hundred in number, are usually placed in a lower and separate building, called the weaving-shed. Nothing is more admirable in the whole arrangement than the manner in which the moving power is conveyed from story to story, from room to room, by means of highly-wrought shafting and wheel-work. The steam-engine may be outside one end of the building, and yet its working efficacy may be felt at the other end, perhaps two or three hundred feet distant. If the mill be in a country district, with a hill close at hand, the architect often plans that the chimney-shaft shall be built on the top of the hill, with a flue leading to it under-ground from the furnaces; this is equivalent to a great increase in the height of the chimney, and in the strength of the draught which passes through the furnace. In the days of Arkwright and the elder Strutt, the mill builders looked out anxiously for a valley, where a stream might afford moving power for a water-wheel; but in the present days of steam-power, the cotton-spinner reckons little on the proximity of a river. In those days, canals were the great channels of communication, along which raw cotton was carried to the mill and manufactured cotton goods conveyed away from it; the transit is now effected almost entirely by railway. There are nearly four hundred miles of railway in Lancashire alone, mostly maintained by the cotton trade; besides those belonging to the cotton districts in the neighbouring counties. These four hundred miles have certainly not cost less than twenty millions sterling; which may, in a certain sense, be regarded as one portion of the fixed capital expended in our gigantic cotton manufacture.

The workers in cotton mills, with the arrangements for their protection, will be noticed in a later article. [Factories.] Some of the numerous processes to which cotton goods are subjected[1] have been described in earlier portions of this work. [Bandana; Bleaching; Calendering; Calico Printing]; and another class of operations will be found noticed under Dyeing.

COTTON TRADE AND CONSUMPTION. Having, in Cotton Cultivation and Supply, passed under review the chief circumstances connected with the growth of this important fibre, and its shipment to the busy marts of industry; and in the article Cotton Manufacture, having described the principal processes whereby the fibre is spun for the use of the weaver—we shall be prepared, under the present heading, to trace the wonderful course of trade in the manufactured commodities.

And first, in relation to our own country, concerning which the available sources of information are abundant and trustworthy.

The unprecedentedly rapid increase in the consumption of cotton in Great Britain, soon after the year 1786, resulted almost entirely from the inventions of Arkwright, Hargreaves, and Crompton, followed, at later dates, by those of Cartwright, Ratcliffe, and Roberts, already adverted to. Had it not been for these inventions, British artisans could not have competed successfully with the spinners and weavers of India. The Hindoos possess so much skill in this kind of work, and are content with so low a rate of wages, that their muslins and calicoes would have continued to beat those of England out of the market, had not the latter been aided by machinery. Even when this difficulty was overcome, the peculiar monopoly of the East India Company retarded the opening of a market for British manufactures. It was not until the present century had considerably advanced that British cotton goods found their way to India in any notable quantity. Another circumstance deserving remark is, that the English weavers were slow in arriving at an equality with the Hindoos in the durability and general excellence of the product; it was the cheapness of price, rather than the improvement of quality, which brought about the revolution in the trade.

It will be convenient and instructive to trace the advance of this remarkable department of British commercial industry in successive epochs.

Before 1800. The statistics of the trade during the last century are not much to be relied upon; many of them were mere estimates rather than authenticated returns. So far as they go, however, they may briefly be mentioned. In the year 1700 there were about 1,000,000 lbs. of cotton used in Great Britain, requiring the services of 25,000 persons to work it up—clearly indicating, by the large ratio of labour to material, a period of hand-spinning and hand-weaving. In 1720, the consumption was 2,200,000 lbs.; and in 1764, about 3,900,000. In 1775, before Arkwright's patent became established, the consumption was 4,800,000, which doubled by the year 1781. With 1786 began the new order of things. In the next following year the consumption was 23,000,000 lbs.; to work up which there were 143 cotton factories, 550 mule-jennies, 50,000 mule-spindles, 20,070 hand-jennies, 1,600,000 jenny-spindles, and 60,000 operatives. In 1790, the consumption was nearly 31,000,000 lbs.; and in 1800 upwards of 51,000,000 lbs. Before the year 1775, only low numbers, or coarse yarn, could be spun, and in a quantity insufficient for the wants of the weavers; but the great inventions of Arkwright, Hargreaves, and Crompton enabled the spinners to overtake the weavers—until Cartwright invented power-loom weaving, when the balance turned the other way. About the year 1790 the British manufacturers began to look out for an increased supply of foreign cotton; they felt that they could work up the raw material more rapidly than it was at that time obtainable. The East Indies effected a little, but only a little, towards augmenting the supply. The United States made an energetic response to the appeal. Eli Whitney's newly invented cotton-gin enabled the planters to clean their cotton for the market with a rapidity greatly exceeding that of the previous process; and thus, with an increased demand and an increased power of supply, the United States cotton trade spread in the way already indicated. During the last ten years of the century, the price of United States cotton varied from about 1*s.* 3*d.* to 1*s.* 6*d.* per lb. on an average of all the qualities.

1801 *to* 1810. The present century opened with every indication of a rapid extension of the cotton manufacture of Great Britain; and the result fully corresponded with the symptoms. The consumption was 54,000,000 lbs. in 1801, and 58,000,000 in 1806; a small portion was re-exported to other countries, in addition to the above, so that the total import was somewhat larger. The price of cotton gradually lowered; but the British manufacture had not yet extended to the degree which would leave any considerable surplus for exportation; nearly all the woven cotton goods were used at home.

1811 *to* 1820. The consumption rose from 90,000,000 lbs. to 150,000,000 lbs. per annum, during this period, after making allowance for a small re-export of raw cotton. Already had United States cotton attained such an ascendancy in the market, that towards the close of this decennial period, it constituted 53 per cent. of all the cotton used in Great Britain—the remainder being 31 per cent. from Brazil, 10 per cent. from the East Indies, and 6 per cent. from the West Indies. British manufacturers had by this time discovered the valuable fact, that, if the East India Company would afford trading facilities, India was quite willing to take in large quantities the produce of our looms. About 800,000 yards of British cotton goods were sent to India in 1814; in 1818 the quantity was 1,600,000 yards; and in 1820 no less than 9,000,000 yards. Altogether, it is supposed that, in 1820, our manufacturers found foreign purchasers for 248,000,000 yards of cotton piece-goods, and 23,000,000 lbs. of cotton-yarn, sold to be worked up in countries where they could weave more cheaply than spin.

1821 *to* 1830. There are conflicting accounts of the quantity of cotton used in Great Britain during these ten years. One authority sets down the quantity imported in 1821 at 157,000,000 lbs., and in 1830 at no less than 264,000,000 lbs.; in each year all except 5,000,000 or 6,000,000 lbs. were worked up in our own mills and workshops. Another authority gives higher figures. One cause of this discrepancy is, that many computers give their statistical entries in *bales*, and then guess at the probable number of pounds in an average bale of the period in question. The prices of cotton at Liverpool, during this decade, varied from 7*d.* to 12*d.* for average United States growths, 8*d.* to 15*d.* for Brazilian, and 5*d.* to 8*d.* for East Indian. It has been computed that in 1830 there were 223,000,000 lbs. of yarn and twist made in Great Britain, 64,000,000 lbs. of this quantity exported, and 442,000,000 yards of cotton piece goods exported—the value of these exports being about 19,000,000*l.*

1831 *to* 1840. We now arrive at a decennial period during which the workers in our cotton mills had become so numerous as to enlist the sympathies of the nation, in so far as regarded the unprotected or ill-protected women and children comprised among the number. What was the nature of the legislative interference, will be noticed under FACTORIES; a few particulars concerning actual numbers will suffice in the present case. The quantity of cotton imported increased with gigantic strides; it was 364,000,000 lbs. in 1835, and 592,000,000 lbs. in 1840. A steady increase took place at the same time in the quantity re-exported for manufacture in foreign countries; but this portion continued to bear a very small ratio to the whole weight. By the year 1840 the United States had acquired a greater ascendancy than at any former period in the supply of cotton to Great Britain; not only had their quota increased, but the increase had been more rapid than that in other countries. Of all the cotton purchased by Great Britain in that year, no less than 76 per cent. was from the United States—the other ratios being, 14 per cent. from the East Indies, 6 per cent. from Brazil, 2½ per cent. from Egypt, and 1½ per cent. from the West Indies and miscellaneous countries. There had been an advance of ratio in quantities in East Indian and Egyptian, and a decline in Brazilian and West Indian. Prices, which in 1835, averaged 10¼*d.* for United States cotton, 14¼*d.* for Brazilian, and 7⅛*d.* for East Indian, fell in 1840 to 6*d.*, 9¼*d.*, and 4¾*d.*, respectively. This was a highly flourishing state of things for the manufacturers; they obtained cotton cheaply and abundantly; they had the command of the best machinery, and an ample supply of labour; and a long continuance of peace maintained a wide field of foreign trade open to them. It was estimated that 281,000,000 lbs. of cotton yarn and twist were spun in Great Britain in 1835, and 407,000,000 in 1840; of these large quantities, 83,000,000 and 118,000,000 lbs. respectively, were exported. The exports also included 558,000,000 yards of cotton piece goods in 1835, and 791,000,000 in 1840. Piece goods and yarn together, the values were supposed to be 22,000,000*l.* in 1835, and 25,000,000*l.* in 1840—though some computers have made these figures much higher. As to the amount of fixed capital invested, Mr. M'Culloch, Mr. Baines, and Mr. Kennedy, all endeavoured to make separate estimates about the year 1835; they proceeded on different bases, and their results were not in harmony; nevertheless, they did not depart very far from a medium estimate of 34,000,000*l.* Mr. Woodbury, an American authority, in comparing the cotton manufacturing operations of different countries for the year 1833, put down Great Britain at 9,500,000 spindles, and 1,500,000 persons directly or indirectly supported by the cotton manufacture. The last-named kind of estimate is one that must always be received with caution; for unless we know the limits which a computor assumes, we can never be sure of the meaning of his results. For instance, there are first the actual workers in the spinning and weaving mills; then there are the hand-loom weavers *out* of the mills; next come the bleachers, dressers, dyers, printers, and calenderers, who finish the woven goods for the market; another group comprises those who manufacture cotton into hosiery, lace, bobbin net, and various other articles; to these must (or may) be added the artisans employed in making the spinning and weaving machines and implements; and lastly, there are the wives and children or other dependents (themselves not engaged in earning money) of men employed in the above-named trades. Computers not only differ in the number of the groups which they include, but they do not always render it clear how far their estimates extend. In the instance of Mr. Woodbury, it is evident that he must have given a very wide extension to the meaning of the terms "supported by the cotton manufacture." The actual workers in cotton factories, in 1835, amounted to 220,134; and the number of power-looms in the mills was 109,626. The *obtainable* power of those looms, if all fully employed throughout the year upon a somewhat heavy class of goods, was estimated at 700,000,000 yards woven in a year; although the real produce was of course much below this. The number of hand-looms at that time could only be guessed at; it was roughly estimated from 200,000 to 250,000. It affords a curious illustration of the vastness of the manufacture, that the cotton weavers in that year used 650,000 bushels of flour, for the mere purpose of dressing the warp-threads before weaving. The factories were ascertained to be 1304 in number—that is, the spinning and weaving mills, in which the 220,134 operatives were engaged; the total number supported by the manufacture, in the wide acceptation above adverted to, was set down at 1,400,000, being less than Mr. Woodbury's estimate made two years before. The commissioners appointed to inquire into the circumstances connected with the employment of women and children in factories (preparatory to legislation on that subject), made a valuable analysis of the mode in which labour was distributed in the mills; from which the following table was prepared, showing the number employed and the wages earned in each department:—

	Number of hands.	Net Monthly earnings.
		£
Cleaning and spreading . .	4,998	8,682
Carding	40,484	75,276
Mule-spinning	65,216	139,661
Throstle-spinning	7,709	11,616
Reeling	14,638	22,817
Weaving	75,055	168,664
Roller-covering	725	1,765
Engineers, &c.	3,975	15,987

The aggregate does not exactly correspond with the 220,134 for the year 1835; but the periods were perhaps not quite identical. Of the total number, 60,393 were men, 65,774 women, and the rest children. The average wages paid at that time to children and young persons, was from 2*s.* 9*d.* per week for boys nine years of age, to 8*s.* 2*d.* for young persons of eighteen; adult wages varied greatly, according to the degree of skill required in the several processes. The cotton yarns woven at that period varied in price between the wide limits of 1*s.* per lb. (for No. 12 water-twist) to 27*s.* per lb. (for No. 250 mule-twist).

1841 *to* 1850. The arrival of this period was marked by a notable manifestation of the influence possessed by the cotton manufacturers and merchants of England. The 'cotton interest' or 'Manchester interest" was now so great, that statesmen began to bend to it in a manner never before exhibited. The immense shipping arrangements at Liverpool, connected with the importation of cotton; the vast monetary dealings between the Liverpool merchants and the Manchester manufacturers; the expenditure of capital in beginning to cover Lancashire with a network of railways, mostly for the accommodation of this particular trade; the mills, the machines, the work-people, employed in the trade—all had now advanced to such a degree of importance, as to render it impossible for statesmen to ignore the fact that a new power had arisen in the north, which must influence the legislation of the country. It was this power, more than any other which can be named, that brought about the systematic change of the import duties on foreign commodities, and especially on corn. The importation of cotton in 1845 was about 1,850,000 bales: equivalent, with the average weight of bales at that time, to about 722,000,000 of pounds; of which 43,000,000 were re-exported. Owing partly to a lessening of supply, and partly to the re-action after a period of excitement, the import of cotton in 1850 exhibited a falling off; it amounted to 1,750,000 bales, or 664,000,000 of pounds, of which 102,000,000 were re-exported. In reference to the total quantity of yarn and twist manufactured, the portion of this quantity which was exported to foreign countries, the length of woven piece goods exported, and the value of both kinds of exports, the two years in question exhibited the following figures:—

	Yarn and Twist manufactured.	Yarn and Twist exported.	Piece Goods exported.	Value of exports.
	lbs.	lbs.	Yards.	
1845	. 495,000,000	131,000,000	1,092,000,000	£26,000,000
1850	. 529,000,000	124,000,000	1,358,000,000	28,000,000

The price of cotton fell in 1845 to a level never before known, and this was one cause of the large importation in that year. Average United States cotton was at 4½*d.* per lb., Brazilian at 6½*d.*, and East Indian at 3*d.* This was a year for large profits among the Lancashire manufacturers; they had an abundance of cotton at a low price, and sent out their manufactured goods to all accessible quarters. The intense desire to gain admission to additional foreign markets, for the sale of English manufactured cottons, was one reason for the vigorous agitation which led soon afterwards to the revision of Customs' duties; on the ground that if foreign countries were permitted to send their raw produce nearly or quite duty free to England, they might the more readily admit English manufactured goods on fair and moderate terms into their own ports. By the year 1850, the price of cotton had risen considerably; the three kinds above named exhibiting averages of 7¼*d.*, 8*d.*, and 5*d.*, respectively. Concerning the operatives by whom the cotton was worked up, there was an estimate in 1846 that the cotton mills of the United Kingdom employed 316,327 persons; of whom 134,091 were males, and 182,236 females. A more detailed estimate, applicable to the year 1850, gave the following figures: cotton mills, 1932; moving-power therein, 83,000 horse-power; spindles, 21,000,000; power-looms, 247,000; children employed in cotton-mills, 14,993; young persons and adults, 315,931; total mill-hands, 330,924; of whom 189,423 were females.

1851 *to* 1859.—We now come to those recent years in the history of the British cotton manufacture which have been marked by great agitation and uneasiness; owing mainly to the extraordinary way in which England is dependent on the United States for a supply of cotton, and to the alarming degree in which any diminution in this supply augments the price of the raw material. It has just been shown that, in the year 1850, the quantity of raw cotton imported was about 664,000,000 lbs. Without touching upon the intermediate years, we will at once proceed to the three most recent years concerning which returns are yet obtainable—1856, 1857, and 1858:—

	1856.	1857.	1858.
	cwts.	cwts.	cwts.
From United States . .	6,964,643	5,846,054	7,439,623
„ Brazil . .	194,197	267,061	196,321
„ Egypt . . .	307,134	219,038	341,360
„ East Indies . .	1,611,577	2,235,162	1,185,023
Other countries .	63,571	87,318	102,961
	9,141,122	8,654,633	9,265,288

Here we see that the Board of Trade returns introduce an additional complexity; we have not only to deal with *bales* and *pounds* of cotton, but in this instance with *hundredweights*. Without calculating the probable number of bales, it will suffice to convert these quantities into pounds, and then we find them to amount in round numbers to the following astounding totals: 1023,000,000 lbs. in 1856; 970,000,000 lbs. in 1857; 1034,000,000 lbs. in 1858. The relative falling off in East India cotton in 1858 may doubtless be attributed to the disturbance of industry and commerce occasioned by the mutiny. A portion of raw cotton, as we have before seen, is sold again by English dealers to foreign countries, chiefly in the north of Europe; this portion amounted, in the three years above-named, to about one-seventh of the total quantity imported. The ratios from different countries, in the first of these three years, were as follow: 71 per cent. of United States cotton, 19 per cent. of East Indian, 5 per cent. of Brazilian, 4½ per cent. of Egyptian, and ½ per cent. from miscellaneous sources. The next table relates to the exports of manufactured cottons, in 1858, in which it will be desirable to distinguish the chief countries to which the goods were sent:—

CALICOES, CAMBRICS, MUSLINS, FUSTIANS, AND MIXED STUFFS.

Countries.	1858.
	£
Hanse Towns	929,466
Holland	540,450
Portugal	718,662
Turkey	2,779,227
Syria	621,904
Egypt	770,078
United States	2,613,588
Foreign West Indies	816,456
Brazil	1,839,425
Buenos Ayres	440,417
Chili	414,156
Peru	491,207
China	1,821,570
Java	532,863
Gibraltar	416,466
British North America	450,780
British West Indies	562,428
East Indies	9,299,359
Australia	612,215
Other countries	5,335,998
	32,006,715
Cotton yarn	9,573,320
Cotton stockings, thread, lace net, and small wares	1,387,549
	42,967,584

In 1856, the total amount had been 38,232,741*l.*; in 1857, it was 39,073,420*l.*

It will be seen that, according to this remarkable table (excluding the entry "Other countries," which is made up of many small items), the largest customers for British cotton manufactured goods are the East Indies, the United States, Turkey, Brazil, and China; these take rather more than half of the whole quantity. Yarn, on the other hand, as the spun material for weaving, is exported most largely to those European countries in which weaving is carried on to a considerable extent; thus, the Hanse Towns and Holland alone purchased cotton yarn from England to the average annual value of about 4,000,000*l.* during the years 1856-7-8. It is necessary to remark, however, that the Hanse Towns (Hamburg, Lübeck, Bremen, &c.) are not in themselves cotton manufacturing towns to any great extent; they are simply the ports at which cotton is landed, for distribution in Prussia and North Germany.

This will be a convenient place in which to advert to a source of confusion likely to lead to error, in comparing English and American cotton statistics. In England the commercial year ends on December 31; but in the United States the date August 31 is adopted—being that on which the total amount of the summer's crop is ascertained. The total crop for the twelve months ending August 31, 1859, was the largest on record, being more than 3,700,000 bales; and England, it is known, took a larger quantity than in any former period of equal extent, being more than 2,000,000 bales; but we cannot compare these numbers strictly with English estimates for 1857 and 1858, for the reasons just stated; and also because it is not certain that the bales present the same average weights as before.

Concerning the mill-industry of recent years, we have two computations, one for 1851 and one for 1856. In 1851, the cotton-mills of the United Kingdom are said to have employed 470,317 persons; of whom 222,612 were males, and 247,705 females. In 1856, the following figures were exhibited: cotton-mills, 2210; moving power therein, 97,000 horse-power; spindles, 28,000,000; power looms, 299,000; children employed, 24,684; young persons and adults, 354,565; total mill-hands, 379,249, of whom 222,027 were females. It is supposed, although there are no means of accurately determining this point, that the total quantity of yarn spun in 1857 was about 740,000,000 lbs.; of which about 24 per cent. was exported in the state of yarn, and the remaining 76 yer cent. worked up in this country into woven and other goods.

There are features connected with these statistical returns, coupled with those of the preceding decennial period, which have excited anxious attention among the Lancashire manufacturers. From 1841 to 1848 there was, at the end of each year, an average stock of cotton on hand, at Liverpool (almost the only port of landing: Glasgow being the next in rank), equal to more than half a year's consumption for the whole of the United Kingdom; but from 1849 to 1857, the stock in hand barely reached eighteen weeks' consumption; and in 1856, it was as low as twelve weeks'. In 1845, which was a golden year for manufacturers, after paying 10,000,000*l.* for raw cotton, they received 45,000,000*l.* for yarn and manufactured cotton goods; leaving 35,000,000*l.* for machinery, fuel, dyeing, bleaching, printing, wages, interest of capital, and profit. Twelve years afterwards a contrast was exhibited, very unsatisfactory to the manufacturers. In 1857, they paid the enormous sum of 26,000,000*l.* for raw cotton, not so much on account of the increase of quantity as the increase of price; the money obtained for the yarn and manufactured goods was 56,000,000*l.*, leaving 30,000,000*l.* for machinery, fuel, dyeing, bleaching, printing, wages, interest, and profit. They had done much more business than in 1845, but under much less favourable circumstances; in 1845, the raw cotton had cost less than a quarter of the money for which the manufactured produce was sold; whereas, in 1857, the ratio amounted to nearly one-half. The gradual diminution of the stock on hand at Liverpool, and the immediate rise of prices in certain years, led to that movement at Manchester which was briefly adverted to in the first of these three articles. When Sir James Weir Hogg, on the part of the East India Company, offered facilities for the researches of any accredited person, who might go out to India to inquire into all the circumstances of cotton culture in that region, the Manchester manufacturers took the matter up, and deputed Mr. Mackay as their commissioner or agent. This gentleman went out in 1852, with an intention of examining the Bombay and Madras presidencies; but his health broke down when his work was only half completed. He died in India; and so much of his report as had been finished was published under the editorship of Mr. Robertson in 1853. The volume contains a large amount of valuable information; and it was fully expected that the Manchester manufacturers would apply it to some useful purpose. But here again was presented an example of narrowed attention to individual interests, and a neglect of the broader interests of the trade,—and it may be added, of the nation in general. There happened to be two years of good supply and moderate prices of cotton and high profits on manufactured goods; and while this state of things lasted, Mr. Mackay's report was forgotten. When, however, the year 1856 exhibited a rise in the prices of United States cotton, and 1857 a still greater rise, manufacturers again took the alarm; again felt it a duty to inquire whether an increased supply of cotton can be obtained from other countries, so as to lessen the dependence of Great Britain on the United States.

It was under these circumstances that the Cotton Supply Association was established in 1857. Many active Lancashire men sought to interest the trade generally in the importance, and even necessity, of fostering the cultivation of cotton in countries where it had hitherto been too much neglected, especially the East Indies. The Association held its first anniversary meeting in April, 1858. During the preceding twelve months, many meetings had been held in the large towns of the north, to elicit opinions by discussion and comparison of data. A general opinion prevailed that India was the chief source to look to. A project was drawn up, to propose to the government an expenditure of 20,000,000*l.* in that country during five years, in the construction of roads, bridges, railways, tramways, piers, landing slips, irrigation canals, and navigation facilities; the interest of the money, and possibly a redemption fund, to be provided for by tolls. Whether such a large demand would have been acceded to under any circumstances, is doubtful; but the whole movement was speedily checked by the formidable mutiny. Even a limited application of 300,000*l.* for some of these purposes could not be obtained. The enormous outlay consequent on the suppression of the mutiny placed the Indian exchequer in a position ill-fitted for the direct undertaking of expensive public works; and the new council for India, after the transfer of the company's powers to the crown, was obliged to direct its energies to the defraying of costs already incurred. The Cotton Supply Association, in the course of its labours, sent circulars to the British consuls in all the cotton-growing countries, inviting information concerning the possibilities of an increase of supply. The replies given comprised many valuable statements. The ruling authorities in nearly all those countries expressed great eagerness to aid the object in view; making applications for good seed and efficient working machinery. The association purchased a hundred tons of the best American cotton seed, and sent it in small quantities to the several countries. Nevertheless, the ruling men in the association, in this their first report, complained in strong terms of the want of sufficient support among the Lancashire capitalists. The cotton dealers of Liverpool and the cotton spinners of Manchester entered with no largeness of feeling into the scheme; they subscribed so slenderly, that the association had not funds for carrying out the intended plans. At the next annual meeting, however, held in May, 1859, the report showed that the second year's operations of the association had been marked by that energy which Lancashire men can (if they will) bring to bear on their proceedings. There was, it is true, a complaint that Liverpool and Glasgow were still listless; but Manchester was on the alert, and so were most of the spinning towns. During the second year the association received two thousand communications from the government departments, the new Indian council, the British consuls abroad, and societies and individuals in various parts of the world, relating to the encouragement of cotton-growing in places suitable for it. Grants of cotton-seed, varying from one bag to two hundred each, had been made and forwarded to Bombay, Madras, Calcutta, Ahmedabad, Hyderabad, Malabar, Ceylon, Singapore, Sydney, Savanilla and Baranguilla in South America, Honduras, Guatemala, Cuba, Jamaica, Hayti, Tunis, Lagos, Fernando Po, Sierra Leone, Cape Coast Castle, Natal, Monrovia, Macedonia, Aleppo, Jaffa, Sidon, Kaiffa, Broussa, Salonica, Constantinople, Messina, Attica, Argolis, Laconia, Arcadia, Achaia, Eubœa, and many other places. Cotton-gins were forwarded to several of the above-named towns and countries; and cotton-presses were sent to Cape Coast Castle. Medals and prizes were offered for the best samples of cotton grown in Liberia. A periodical called the 'Cotton Supply Reporter' was established, containing useful communications obtained from all parts of the world relating to the growth of cotton; it was regularly forwarded to all associations and individuals likely to be able to aid in the general object. Public trials of cotton-gins were held, with the view of concentrating the attention of machinists and inventors, in the hope of ultimately obtaining machines of a more efficient character than those at present in use. Acting on suggestions received from India, the association began experiments and invited assistance on the improvement of the simple Indian *churka*, or roller-gin,—appreciating the importance of having some easily managed contrivance which the Hindoos could use in their own cottages. If this were done, the Hindoos might be able to convey to the trading stations clean cotton instead of cotton in the seed, thereby reducing to one-third or one-fourth the weight to be carried. It was expected that the autumn of 1859 would witness the arrival at Liverpool of a large quantity of excellent cotton from places in which the cultivation had been mainly due to the exertions of the association.

We may now give a few figures concerning duty, prices, and capital, in relation to the British cotton manufacture.

The highest duty ever charged by the Customs' department on the raw material imported was between the years 1805 and 1809, when it amounted to 25*s.* 3¾*d.* per cwt. (about 3*d.* per lb.) for the produce of "non-favoured" countries. The lowest duty prevailed between 1833 and 1845, when it amounted to 4*d.* per cwt. on cotton from British provinces, and 2*s.* 11*d.* per cwt. on cotton from all other countries. The duty was altogether removed in the last-named year. The prices of the manufactured goods are subject to two remarkable disturbances: one due to the cheapening effects of improved machinery and processes; and the other due to the difference in the amount of labour on fabrics similar in weight, but not in fineness. It is a recorded fact that sixty years ago as much as 6*s.* per yard was paid for a calico wedding dress, which would now be manufactured at about 3*d.* The same kind of yarn which sold for 38*s.* per lb. in 1786 can now be sold with a profit at 2*s.* 6*d.* At the present time a pound of cotton-yarn is in some cases worth only 11*d.*; in others, 21*s.* 6*d.*; depending for the contrast almost wholly on the difference in the amount of labour bestowed: in the last-named case the cotton costs 3*s.* 6*d.*; the labour, 18*s.* Concerning the amount of capital now invested in this colossal manufacture, the materials for computation are doubtful. Mr. Ellison, in 1858, estimated that there were 2210 cotton-mills in the United Kingdom; that they contained 28,000,000 spindles; that if all the buildings and all the spinning materials were estimated in cost at so much per spindle, they might be taken at about 24*s.* per spindle; that wear and tear had probably brought down this value to 18*s.*; that there were 299,000 power-looms, which, having cost 24*l.* each, might be set down at 20*l.* He thence derived the following figures:—

	£
Present value of mills and spinning machinery . .	25,000,000
Present value of power looms	6,000,000
Floating capital, stock in hand, wages advanced, &c. .	14,500,000
Cash at bankers	10,000,000
	55,500,000

In most of the foregoing details Ireland has been included with Great Britain. It has never occupied a distinguished rank in this department of industry. The manufacture was first introduced into Ireland in 1770, and it gradually extended; but the high price of fuel has always been a serious drawback. Many Glasgow firms send out spun yarn to Ireland to be woven into muslins and other cotton goods by hand-loom. It was supposed in 1855 that about 5000 persons were employed in the cotton manufacture in Ireland, chiefly in the province of Ulster.

Having thus traced the operations in the United Kingdom, we shall next take a rapid glance at the rise and present state of the cotton manufacture and the consumption of raw material in the chief foreign countries.

France.—The first import of cotton into France is said to have been in the year 1770. The first authentic record of quantities was in 1787, when the import amounted to about 10,000,000 lbs. From that time, during the long and dreadful war, little progress was made. In 1815 the quantity rose to 36,000,000 lbs.; in 1820, 45,000,000; in 1825, 55,000,000; in 1836, 57,000,000; and in 1846, 97,000,000: in 1850 it reached 375,000 bales; in 1856, 506,000 bales; and in 1857, 484,000. There is here the same complexity between *pounds* and *bales* as we have had occasion to notice in reference to Great Britain; and there is a further source of confusion in the adoption of the weight *kilogramme* in the French commercial tables. If, however, we assume the bale to be 400 lbs., the busiest year in the above list (1856) exhibits an import of about 200,000,000 lbs.—by far the largest ever known on the continent of Europe. The exports of French cotton goods, after the conclusion of the great war, rose in the following way: 29,000,000 francs in 1820, 43,000,000 in 1825, 55,000,000 in 1830, 57,000,000 in 1833. In 1850, the money paid for raw cotton was estimated (in English currency) at 10,000,000*l.*, and the value of the manufactures produced at 16,000,000*l.*—indicating, if the entry be correct, either a very coarse quality of goods, or a very low rate of wages and profits. In the same year the French government tables gave the following figures: Cotton factories, 694; mule spinning-machines, 115,157; other spinning-machines, 15,362; spindles, 3,442,550; male adult operatives, 108,663, with average wages of 1*s.* 8*d.* per day; female adult operatives, 89,492, wages 10*d.*; children, 44,273, wages 5*d.*

Switzerland.—The Swiss do not wear many cotton garments; but they manufacture cotton for export to neighbouring countries. The first spinning machine was established at St. Gall in 1800. A considerable part of the Swiss manufacture consists in weaving by hand-looms the yarn which is imported ready spun from other countries; and in dyeing and printing piece-goods which have been woven abroad; in the latter department of the trade they have acquired a high reputation. A portion of the raw cotton imported by France is sold again to Switzerland. The republic worked up 22,000,000 lbs. of cotton in 1843, and 27,000,000 lbs. in 1851. The spinning capabilities have risen from 259,000 spindles in 1824, to about 1,350,000 spindles in 1858, in 270 factories.

Holland and Belgium.—These two countries are about on an equality in relation to the cotton manufacture. They produce fine, soft, and durable cotton goods. Much of their cotton is purchased from England. One of the curiosities of their trade is, that considerable quantities of yarn, when dyed red, are re-exported to England, for transmission to the East Indies; this seems to imply, that the quality of the dye is preferred to that of England. The cotton-trade of Holland is believed to be chiefly a transit one, the bales being sent onwards to the Rhenish districts. Taking the two countries together, Holland and Belgium imported 106,000 bales in 1850, and 170,000 bales in 1857. Belgium was supposed to have about 420,000 spindles in 1845, chiefly in the province of East Flanders.

Germany and the Baltic Ports.—Under the somewhat indefinite geographical designation, Germany, it is difficult to discover what is the amount of the cotton manufacture; for in some returns Prussia is included, but in others excluded; while the Baltic ports of landing might include many countries besides those belonging to the Germanic Confederation. It will probably include nearly the whole of the imports of northern and central Germany, Prussia, Russia, Sweden, and Denmark, if we combine the statistics of Germany and the Baltic Ports. In 1850 the importation amounted to 234,000 bales; in 1857 it had increased to 378,000 bales; and in 1856, it had reached 520,000 bales; the extraordinary activity being probably due to the renewed operations of peace after the Russian war of 1854–5. If the average of 400 lb. per bale may be taken (it was probably less than this), the imports of the year in question amounted to 200,000,000 lbs.

Although the imports of the respective German States cannot here be separated, the manufactures of several of them admit of being noticed. All the German States together were said to have 1,815,000 spindles in the year 1846, and 2,060,000 in 1857; but it is not clear whether Prussia was included in this group. Much of the cotton imported by Prussia in 1854–55 was merely in transit to Russia, whose ports were practically closed during the war. *Prussia* counted 5880 workers in cotton mills, and 172,000 spindles, in 1846; in 1858 there were supposed to be 425,000 spindles, in 26 cotton mills. *Saxony* is making a steady advance in the cotton manufacture, as shown by the following figures:—84 mills and 360,000 spindles in 1830; 116 mills and 475,000 spindles, in 1845; 134 mills and 605,000 spindles in 1858. The mills are mostly worked by water-power. The spindles vary from 120 to 21,000 in each factory, and mostly weave coarse yarns. In the year 1855 about 24,000,000 lbs. of cotton were worked up into 20,000,000 lbs. of yarn, worth 800,000*l.* The cotton was about in equal quantities from the United States and the East Indies. The fixed capital invested in the manufacture was estimated at the rate of about 30*s.* per spindle, and the working capital at 27*s.* There were 5979 men and boys employed, 5717 women and girls, or 11,696 altogether. The aggregate of wages paid was 136,000*l.*—about 11*l.* 11*s.* per head, or 4*s.* 5*d.* per week each operative on an average: a rate very much lower than that which prevails in England. It was computed that, of every 100*l.* received for the manufactured goods, 67*l.* went for raw cotton, 16*l.* 10*s.* for wages, and the remaining 16*l.* 10*s.* for working expenses, interest on capital, and profit; this affords another proof that both wages and profits must have been low. Of *Bavaria* we learn only a few facts; that in 1847 there were 11 mills, 56,000 spindles, and 1140 mill hands; and that by the year 1858 the mills had somewhat increased in number. The German States of *Hanover, Wurtemberg, Baden, Oldenburg,* and *Nassau,* were collectively entered in 1858 as possessing 32 cotton mills and 480,000 spindles.

Russia.—For the reasons already stated, the amount of import of cotton into Russia in recent years is uncertain; there are records, for instance, that 187,000 bales were landed at Baltic ports in 1857: but we do not know how many of these ports were Russian. Concerning the manufacture, there were 700,000 spindles in 1846. In 1853 the government returns told of 495 cotton mills, 2,000,000 spindles, 112,000 mill hands employed, and 41,000,000 lbs. of yarn produced. The import of raw cotton is steadily increasing, and that of English-spun yarn decreasing; showing that the Russians can now spin for themselves at a profit. There is good calico-printing conducted in the governments of Moscow and Vladimir.

Norway and Sweden.—The cotton trade and manufacture in these northern countries are small; but they are steadily increasing. It is computed that about 22,000,000 lbs. of cotton were imported in 1856, mostly at Gottenburg.

Austria and Italy.—It is not easy to separate the accounts of these two countries; for although most of the cotton landed at Trieste is forwarded north-eastward to Austria, Bohemia, &c., some of it is consigned to northern Italy. If we combine the imports at Trieste with those at all the Italian ports, we arrive at an average in eight years, 1850 to 1857, of about 160,000 bales; they exhibit a gradual diminution at Trieste, and a remarkable increase at the Italian ports—due, possibly, to a liberal policy on the part of the government of Piedmont. In Austria and Austrian Italy it is computed that, in 1846, there were 203 cotton mills, 1,270,000 spindles, and 28,000 mill hands: and that, in 1857, the mills had increased to 239, and the spindles to 1,740,000. The looms, in 1851, were 24,000 in number, mostly hand-looms. There is a probability that some of the cotton spun and woven in Bohemia and Moravia comes through France or Germany; and that thus the imports at Trieste are not a fair index to the totality of the Austrian manufacture.

Spain.—This fine but misgoverned country, in cotton manufactures as in most other things, is far behind the position which she ought to occupy. The spinning and weaving of cottons have slightly revived within the last few years; but they are far below the proper level for a country with fifteen millions of inhabitants. The cotton imported in 1857 was only 82,000 bales.

United States.—We now cross the Atlantic, and briefly trace a manufacture which is advancing with rapid strides. In the year 1789, the State of Massachusetts procured models of carding and spinning machines from England, and manufactured machinery to be put in operation by water-power; but the first cotton mill actually set to work in the United States was at Rhode Island in 1791. A second was built in 1792. Then a series of years occurred, during which the Americans made no advance whatever in the manufacture; the Southern States eagerly and successfully endeavoured to improve the culture and increase the sale of the raw material; but the Northern States took no steps to advance the spinning and weaving. It was not until the present century that anything noticeable was effected. In 1803 there were three cotton mills altogether, which were increased to four in 1804. In 1805 and the two following years there were ten mills built in Rhode Island and one in Connecticut. The war with England in 1812 induced the Americans to pay more attention to the home manufacture of cottons; and from that year this branch of industry has never flagged. The mills, which were only numerous enough to use up 1000 bales of cotton in 1805, and 10,000 bales in 1810, used 90,000 bales in 1815—employing (or perhaps supporting) in various ways 100,000 persons, and 40,000,000 dollars of capital. After this, power-loom factories were erected, and then the manufacture extended very rapidly. In 1830 the cotton worked up amounted to 127,000 bales; and in 1840 to 389,000; the value of the manufactured produce in these two years was about 4,700,000*l.* and 9,700,000*l.* respectively. America had too brisk a demand at home for these goods to induce her to export much; down to 1834 the export of cotton barely reached a value of half a million sterling annually. The cotton worked up in 1850 was about 640,000 bales; the mill hands were about 92,000; and the gross value of the manufactured produce 12,900,000*l.* In 1855 the cotton consumed was set down at 689,000 bales; and the value of the manufactured cotton goods at 14,800,000*l.* There can thus be no question that the cotton manufacture has spread widely and rapidly in the United States. Some English manufacturers fear that the Americans will by-and-bye spoil our market for spun and woven cotton goods in that country, and will even undersell us in other countries. They point to the fact that while our total exports of cotton were higher in 1857 than in 1856, and higher in 1858 than in 1857, that portion of the exports which went to the United States receded—being (in woven goods, excluding yarn, hosiery, and lace) 3,800,000*l.* in 1856, 3,100,000*l.* in 1857, and 2,600,000*l.* in 1858. On the other hand, as England is the great source for highly effective machinery; as coal and iron are abundant and cheap; and as wages are somewhat lower than in the United States,—it would appear that our country ought not to lose much in the race, in the long run.

A few words concerning the total consumption of cotton in *all* countries. In 1835, Mr. Woodbury, Secretary of the United States' Treasury, compiled, by order of the American Congress, and presented to the House of Representatives, a Collection of tables and notes on the cultivation, manufacture, and foreign trade of cotton. These were apparently prepared from all the authentic data at that time obtainable. Leaving out those Asiatic and African countries of whose industrial concerns we know so little, he estimated the consumption of cotton, in all the countries where commercial statistics are of any avail, at 490,000,000 lbs. in 1791; 630,000,000 lbs. in 1821; and 900,000,000 lbs. in 1834. Mr. Bazley, Chairman of the Manchester Chamber of Commerce, has made an estimate that in 1853 there were 1,500,000,000 lbs. worked up in Europe and America; of which, about one-half was wrought in England, and one-sixth in the United States. He further estimated, that if all this cotton were spun into the yarn known as No. 40, it would have required 47,000,000 spindles for this work. Another estimate, made in 1857, was to the effect that all the cotton worked up in Europe and America, excluding Asia and Africa, would in 1856 have amounted to 1,795,000,000 lbs. The probable *European* consumption for 1859 is about 1,300,000,000 lbs.

The most trustworthy authorities on the subject of this article are the same as those enumerated at the end of COTTON, CULTIVATION AND SUPPLY.

COUCH GRASS (*Triticum repens*) is a common and most troublesome weed which infests arable land, especially that which is of a light and mellow nature. It is perennial, and propagated both by seed and by extension of the root, which is long and jointed; each joint produces a fresh shoot, which, in a favourable situation, soon becomes a new parent plant, creeping along under the surface of the ground, and spreading over a whole field with great rapidity. It appears above ground like a blade of grass, or young wheat, which, in its tender state, is readily eaten by sheep. A seed stem afterwards shoots up, bearing a spike, composed of a middle rachis and alternate spikelets on each side. Each of these produces three or four seeds, protected by a long pointed chaff. Many of the seeds never come to perfection, owing to the increase of the roots; but in stiff ground and permanent pastures the roots are prevented from spreading, and then the seeds ripen. The principal propagation of the plant is by the root. The destruction and extirpation of couch grass is one of the first things which an experienced farmer sets himself to on taking occupation of land which has been neglected by the preceding tenant.

There is no law in this country which obliges a tenant to keep his lands free from weeds. There is something of the kind in Belgium, with respect to thistles and weeds which propagate by seed. An agricultural code is necessary to protect the landlord, and to prevent the woeful waste of labour produced by carelessness and bad management; and until such a code is established by the good sense and good feeling of neighbours, agriculture will never make rapid progress.

To extirpate couch grass a dry time must be chosen in summer; the land must be ploughed with a shallow furrow, to bring the roots to the surface; when the land is dry, it must be rolled to break the clods, and all the roots which lie near the surface must be gathered by the harrows or the couch rake. Sometimes the roots are matted into tufts, which can only be got up by means of a fork or prong. In this case no manual labour should be spared, especial care being taken not to break the roots, but to get them out whole, with all their offsets, if possible. After this, Finlayson's harrow may be used on light lands; or an instrument of a similar nature, called in Scotland a *grubber*, which will bring up all the roots that are within six or eight inches of the surface. When all the couch has been apparently eradicated, there will still remain a sufficient number of pieces and joints, broken off by the instruments and left in the ground, to produce a fresh crop of couch grass, especially if the land is frequently stirred, and showers intervene. Hence the vulgar notion that some lands breed couch, and that it is useless labour to be at much expense to eradicate it. In very heavy land, couch grass is easily kept down if an opportunity be taken to plough it to the surface in dry weather. The stiff clods in which the roots are entangled contract in drying, and in contracting destroy the texture of the root; when they crumble after a shower, the couch may be collected by hand, and burnt or carried away.

When a quantity of the roots of couch grass has been collected, they are usually burnt in heaps on the ground; the ashes serve to enrich the land in some degree. The curious in such matters do, however, assert that a much more profitable use may be made of them. When they are cleaned from the earth which adheres to them, they are found to be nutritious and farinaceous. Pigs eat them greedily; horses and cows will also eat them, especially when boiled or steamed; and weight for weight they contain not much less nutritious matter than potatoes. By maceration and washing, a good fecula is obtained, which, with hot water, forms a jelly-like arrow-root. The decoction of the root has been recommended as a cooling and demulcent beverage, and not without apparent reason; but if it be not thought worth while to wash and steam the couch for food, it is still more profitable to decompose it by means of lime than to burn it. For this purpose it should be gathered into a large heap and watered to induce fermentation. When it has heated, it should be turned over and mixed with quick lime in a considerable proportion; after two or three turnings with the spade, with an interval of a few weeks, it will be found converted into rich mould, which may then be spread over the land, either as a top-dressing for clover and artificial grasses, or ploughed in with the seed, where this method is practised.

To keep the land free from couch grass occasional summer tillage is necessary, which may be given when turnips are sown, or after an early crop, such as tares cut green, *Trefolium incarnatum*, or winter barley, without losing a crop. In a well-managed farm, couch grass should no more appear than docks or thistles. In Belgium a slovenly farmer is called a couch grass farmer.

Dogs eat the blade of couch grass from instinct to purge and vomit, and hence it has been named, in French, *chien-dent*, or *dog's tooth;* but the shape of the young shoots from the root may also probably have led to that name, for they have a great resemblance to a canine tooth.

It has been doubted whether, in some situations, couch grass might not be cultivated to advantage for its roots; no experiments, however, have been made in cultivating this prolific plant, as far as we know; but it is not unworthy the attention of those who take a pleasure in increasing the resources of agriculture. In years of great scarcity, the root of couch grass has been used in northern countries, mixed with flour, in making bread. It contains nothing unwholesome, and has a considerable resemblance in taste to the potato. The water in which the root of couch grass has been boiled may be used in the manufacture of bread; it would probably add considerably to the weight of the loaf when baked, but may perhaps communicate an unpleasant taste to it.

COUCHING. [CATARACT.]

COUGH, a violent expulsion of air from the lungs, attended, when the act of coughing recurs in rapid succession, that is, when there is a fit of coughing, with correspondingly rapid inspirations. Cough is a violent and sonorous expiration, during the effort of which a much greater quantity of air is expelled from the lungs than is returned by the corresponding act of inspiration.

The mouth, nose, fauces, pharynx, larynx, trachea, and bronchi, are lined by a highly irritable and exquisitely sensible membrane. That portion of this membrane which lines the air passages, properly so called, namely the larynx, trachea, and bronchi, possesses the properties of irritability and sensibility in so great a degree, that it cannot endure without the most violent excitement the slightest contact of a foreign body. It is necessary to the due performance of the function of the lung, one of the most important of the organic circle, that the tubes which lead to it should always be perfectly unobstructed; should invariably present to the air a free and uninterrupted passage. Among the expedients adopted to secure this purpose, one of the most important consists in the disposal and action of the membrane which lines the internal surface of the air-tubes. This membrane abounds with blood-vessels and nerves, by the action of which a large quantity of water is constantly separated from the blood, by which the tubes are kept in a state of perfect suppleness and moisture. A layer of the thick, tenacious, and viscid substance, called mucus, also separated from the blood by this membrane, is spread over its entire surface, by which it is defended from the irritating properties of the air, with which it must always be in contact. Moreover, the heat generated by the process of secretion warms the air in its passage to the lungs; and so great is the degree of heat communicated to the air during its progress, that before it reaches the lung it is brought to the same temperature as that of the blood. Accordingly when the lining membrane of the air passages is sound, when the temperature of the air ranges within a certain limit, and when the air is pure, holding in solution or suspension a foreign and noxious body, the external cold exciting air passes deep into the interior of the body, into the very centre of the chest, not only without occasioning irritation, but even without producing sufficient sensation to induce consciousness. But when either of these conditions is changed, the state natural to the respiratory process is disturbed; irritation is excited; warning is given that some danger threatens the system; and an effort is made to remove the offending cause. The warning is announced, and an effort is made to remove the danger, by the act of coughing. [CATARRH; BRONCHITIS; PHTHISIS; LUNGS, DISEASES OF; CROUP.]

COUMARIC ACID. [COUMARIN.]

COUMARIN ($C_{18}H_6O_4$). An odoriferous crystalline principle found in the Tonka bean (*Coumarouna odorata*, or *Dipterix odorata*), in the common Melilot (*Melilotus officinalis*), in Woodruff (*Asperula odorata*), and in the sweet-scented Vernal Grass (*Anthoxanthum odoratum*), to which the scent of hay is owing.

To prepare coumarin, coarsely powdered tonka beans are digested for several hours in hot alcohol of 80 per cent. After filtration, the greater part of the alcohol is recovered by distillation, and when the residue begins to appear turbid, water is added, by which means the coumarin is precipitated in a more or less crystalline state. It may be obtained pure and colourless by treating with animal charcoal, and recrystallisation from alcohol.

Coumarin crystallises in rectangular plates. It melts when heated to 122°, and at 518° boils, and sublimes without decomposition. It has an agreeable aromatic odour and a burning taste, is but slightly soluble in cold water, freely so in boiling water or dilute acids. Chlorine, bromine, and iodine act upon it, and yield crystalline compounds.

Nitrocoumarin ($C_{18}H_5(NO_4)O_4$), containing an equivalent of NO_4 in the place of an equivalent of hydrogen, is formed when coumarin is gradually added to cold fuming nitric acid; dilution with water causes the nitrocoumarin to precipitate in snow-white flocks. Hot nitric acid converts it into picric acid.

Nitrocoumarin crystallises from solution in alcohol in white silky needles. It melts at 338°, at a higher temperature sublimes without decomposition, and condenses in pearly crystals.

Coumaric acid ($C_{18}H_8O_6$) is produced when coumarin is boiled in strong solution of potash. Upon diluting with water and adding excess of hydrochloric acid, it is precipitated in the form of lustrous transparent plates.

Coumaric acid is colourless. It has a bitter taste. It is soluble in alcohol, ether, and water. It melts at 374°, and at a higher temperature sublimes, but with partial decomposition. Fused with hydrate of potash, hydrogen escapes, and acetate and salicylate of potash remain.

$$\underbrace{C_{18}H_8O_6}_{\text{Coumaric acid.}} + \underbrace{2KO, HO}_{\text{Hydrate of potash.}} = \underbrace{C_{14}H_5KO_6}_{\text{Salicylate of potash.}} + \underbrace{C_4H_3KO_4}_{\text{Acetate of potash.}} + \underbrace{H_2}_{\text{Hydrogen gas.}}$$

The *coumarates*, containing an equivalent of metal in the place of an equivalent of hydrogen in coumaric acid, are mostly insoluble precipitates, obtained by double decomposition.

COUNCIL, OF THE CHURCH, an assembly of prelates who meet, being duly convoked by the legitimate authority, for the purpose of defining questions of doctrine, or making regulations or canons in matters of discipline. There are various sorts of councils:

1st, General or Œcumenic councils, which are considered as a representative and legislative assembly of the whole Church, and to which all bishops are summoned. A list of these councils will be given hereafter. In the early ages of the Church the general councils were convoked by the Roman emperor; they have been since convoked by the pope, at least for the Western or Roman church. The authority of the general council is considered as binding on the whole Church only in matters of faith, when the canon establishes a dogma which it enjoins all the faithful to believe, under pain of anathema and heresy. In matters of faith the Roman church considers the general council to be infallible; some say, however, only after its canons have been confirmed by the pope. All bishops have a right of attending and voting in the general council; the abbot and generals of monastic orders have also been admitted to vote in most councils by consent of the council. Priests and monks have also attended the councils as theologians and advisers, with a consultative but not a deliberative vote. In the Western church, the pope, or his legate for him, presides in the council. For a council to be legitimate, it is required that all the bishops should be called to it, whether they attend or not, except those who are declared by the church to be schismatic or heretical, and all deliberations should be free and unconstrained.

2nd, National councils, consisting of the bishops of a whole kingdom or state, which can be convoked by the respective sovereigns; but their authority is not considered universal over the whole Church.

3rd. Provincial councils are convoked by the respective metropolitans, with the consent of the sovereign. A bishop may also convoke a diocesan council, with the consent of his superior. (Benedict XIV. 'De Synodo Diocesana.')

The Church of Rome reckons several councils, though not œcumenic, previous to that of Nice; the earliest of which seems to be that held at Jerusalem about the year 50 of our era, which was attended by the apostles Peter, John, James, Paul, and Barnabas, and which is mentioned in the fifteenth chapter of the Acts of the Apostles.

SERIES OF GENERAL OR ŒCUMENIC COUNCILS.

Nice, the Council of, was the first and most important œcumenical council held in the Christian church. It was convened by the emperor Constantine, for the purpose of settling the Arian controversy, after he had in vain attempted to reconcile Arius and Alexander, the leaders of the two opposing parties in that dispute. The council met at Nicæa in Bithynia, in the year 325, and sat probably about two months. It was attended by bishops from nearly every part of the East; but few came from Europe, and scarcely any from Africa, exclusive of Egypt. According to Eusebius, there were more than 250 bishops present, besides presbyters, deacons, and others. Some writers give a larger number. The account generally followed is that of Socrates, Theodoret, and Epiphanius, who state that 318 bishops attended the council. The chief question debated in the council of Nice was the Arian heresy. Eusebius of Cæsarea proposed a creed which the Arian party would have been willing to sign, but it was rejected by the council, and another creed was adopted as embodying the orthodox faith. The most important feature of this creed is the application of the word *consubstantial* (*ὁμοούσιος*) to the Son, to indicate the nature of his union with the Father; this word had been purposely omitted in the creed proposed by Eusebius. The creed agreed upon by the council was signed by all the bishops present, except two. The council excommunicated Arius, who was immediately afterwards banished by the emperor. [ARIUS, in BIOG. DIV.] The time for the celebration of Easter was also fixed by this council, in favour of the practice of the Western church. [EASTER.] It also decided against the schism of Meletius. The only documents which have been handed down to us from this council are its creed, its synodical epistle, and its twenty canons. These canons contain no catalogue of the books of the Bible.

Constantinople, First Council of, convoked by the Emperor Theodosius I., in 382, confirmed the canons of the council of Nice, and established the dogma of the divinity of the Holy Ghost against the attacks of Macedonius. The council consisted of 150 eastern bishops, who decided among other questions that the Bishop of Constantinople should take rank next to the Bishop of Rome. The canons of this council were acknowledged by Damasus, bishop of Rome, and the other western prelates.

Ephesus, Council of, convoked by Theodosius II., in 431, consisted of about 200 bishops, and was attended by the legates of Celestinus, bishop of Rome. It condemned Nestorius. [NESTORIUS, in BIOG. DIV.]

Calchedon, Council of, convoked by the Emperor Marcianus, in 451, consisted of 630 bishops, and the legates of Leo I., bishop of Rome. It condemned the spurious council of Ephesus in 449, which had approved the doctrines of Eutyches and of Dioscorus concerning the two natures in Jesus Christ. [EUTYCHES, in BIOG. DIV.]

Constantinople, Second Council of, convoked by Justinian, in 553, condemned the tenets of Origenes, as well as the doctrines known by the name of the "three chapters." The canons of this council were first disapproved, and afterwards sanctioned, by Vigilius, bishop of Rome. [ORIGENES and VIGILIUS, in BIOG. DIV.]

Constantinople, Third Council of, in 680, convoked by the Emperor Constantine Pogonatus, confirmed the canons of the five previous œcumenical councils, and condemned the tenets of the Monothelites, an offshoot of the Eutychians.

Nice, Second Council of, convoked by the Emperor Constantine, son of Irene, in 787, consisted of above 350 bishops, and was attended by the legates of Pope Adrian I. It condemned the Iconoclasts, and sanctioned the worship of images in the churches. The authority of the above seven councils is acknowledged by the Greek as well as the Latin churches.

Constantinople, Fourth Council of, convoked by the Emperor Basilius, in 859, and attended by the legates of Pope Adrian II., condemned the schism of Photius, and restored Ignatius to the see of Constantinople. [PHOTIUS, in BIOG. DIV.]

Lateran, First Council of, styled the Ninth Œcumenic, was convoked by Pope Calixtus II., in 1123, and consisted only of the Western or Latin bishops, the Greek Church having completely separated itself from that of Rome long before. It made several canons of discipline against simony, clerical concubinage, and the alienation of church property: it placed the incumbents of parishes under the superintendence of the respective bishops, and bestowed indulgences on those who took the cross for the defence of Palestine.

Lateran, Second General Council of, convoked by Innocent II., in 1139, condemned the antipope Anacletus, and his patron Roger, Count of Sicily; condemned also the heresies of Peter of Bruis, and of Arnaldo of Brescia, and made several canons of discipline.

Lateran, Third Council of, convoked by Pope Alexander III., in 1179, after his reconciliation with the Emperor Frederic I., made many canons of discipline and morality; and in its last canon, after anathematising the Cathari, Patarini, Albigenses, and those who afforded them protection, it stated that, although the Church abhors the shedding of blood, it does not refuse the countenance and support of the temporal laws of Christian princes, because the fear of corporal punishment is sometimes efficacious in producing spiritual reformation. The Church, therefore, allows the faithful to take up arms against the anathematised heretics, Cotteraux, Brabançons, and others, who were carrying desolation everywhere, and places those who will fight them under its own especial protection. These Cotteraux, &c., appear to have been a kind of lawless partisans in the pay of turbulent barons, who were mixed up with the sectarian feuds of the times, especially in France. Jews and Saracens were forbidden by the council to possess Christian slaves.

Lateran, Fourth Council of, convoked in 1213 by Pope Innocent III., met in November, 1215, and was attended by the patriarchs of Constantinople and of Jerusalem (Constantinople being then in the hands of the Latins), and by above 400 bishops. It was opened by the pope in person. It sanctioned seventy canons, or decrees, which had been framed by the pope, especially on matters of discipline; and its regulations are often quoted by canonists on questions of marriage, benefices, the election of bishops and abbots, &c. It enforced auricular confession, at least once a year, on all the faithful who have reached the age of discretion, forbidding the confessor to reveal any part of the confession, under pain of deposition and confinement for life in a monastery. It enjoined that, to every cathedral or collegiate church there shall be appointed a teacher of grammar and other arts, for the poor of the laity as well as of the clergy, who shall be taught gratis. In the metropolitan churches there was to be also a professor of theology, to teach and explain to the priests and other churchmen the Holy Scriptures and the care of souls. The council likewise promulgated an exposition or profession of faith, in which the doctrine of transubstantiation was expressly included. The council anathematised all heresies contrary to any part of the said profession; and decreed that heretics, after being condemned by the Church, shall be given over to the secular powers, which are enjoined to drive away from their territories all such heretics; and if the temporal lord neglect to do so, he shall be excommunicated by the bishop; and if, within a year, he does not make his submission, information shall be given to the pope, who will release his vassals from their oath of allegiance, and will give the lands of the refractory feudatory into the hands of an orthodox feudatory, saving the rights of the superior or paramount lord, provided the latter makes no obstacle to the execution of this ordinance. The Gallician theologians, however, reject this canon, as an abuse of power on the part of the council, or rather of the pope who had framed the canon. (Richard, 'Analyse des Conciles;' 'Concile Quatrième de Lateran.')

Lyon, First Council of, convoked in 1245 by Pope Innocent IV. for the extirpation of heresy and schism, for the affording of assistance to the Christians of Palestine, and also to judge of the charges against the Emperor Frederic II., whose councillor, Thaddeus of Suessa, undertook to defend his master. After listening to his defence, the council excommunicated Frederic; and then the pope, in presence of the council, pronounced sentence of deposition against that emperor. It was not the council that assumed to depose Frederic; nor did Innocent IV., as Bossuet remarks, support his sentence by alleging the sanction of the council to it, as he alleged in other decrees which he issued in the same council; the pope merely says that he pronounced the sentence of deposition in the presence of the holy council assembled. The council also ordered a new crusade for the recovery of the Holy Land, and made provision for the funds required for the purpose.

Lyon, Second Council of, convoked in 1274 by Pope Gregory X., for the object of reforming discipline and the morals of the clergy, for the reunion of the Greek Church, and for the assistance of the Christians of Palestine. The assembly was very numerous, consisting of more than 500 bishops and 1000 inferior dignitaries of the Church, besides the ambassadors of many princes, especially of Michael Comnenus, emperor of Constantinople, who wrote to profess his adherence to the orthodox Roman Catholic faith, and to acknowledge the primacy of the see of Rome. Thirty-eight Greek prelates sent in likewise their act of adhesion. The council made several regulations concerning the election of bishops, and the appointment of parish incumbents, and the administration of church property.

Vienne (in Dauphiny), *Council of,* convoked by Pope Clement V., in 1311, condemned the order of the Templars, and the pope suppressed the order and confiscated their property. [TEMPLARS.] It likewise condemned the so-called Beggars, Fratricelli, and other heretics, and made several regulations of discipline concerning the monasteries and hospitals. It also promulgated a profession of faith concerning the human nature of Jesus Christ, according to the testimony of St. John.

Constance, Council of, was assembled in 1414 at the request of the emperor Sigismund, chiefly to put an end to the great schism, during which John XXIII., Gregory XII., and Benedict XIII., each claimed the rank and office of sovereign pontiff. The Council deposed all three, and elected Ottone, cardinal Colonna, as legitimate pope, by the name of Martin V. It was on this occasion that a canon or decree was passed, asserting the supremacy of a general council over the pope. Gregory and John XXIII. submitted to this decision, the latter after much demurring; but Benedict continued the schism in Spain to the time of his death. The Council was also engaged in the trial of John Huss, who was summoned and appeared before it, and was arrested by order of the Council, notwithstanding a safeguard from the emperor. His doctrines were condemned as heretical, and as he would not retract he was publicly degraded from his priestly office, and then consigned to the civil magistrates, who by order of the emperor had him burnt. For the peculiar opinions of Huss, some of which concerned doctrine, and others discipline, see HUSS, JOHN, in BIOG. DIV. The Council condemned likewise the doctrines of Wycliffe, most of which were identical with those of Huss. Jerome of Prague, a disciple of Huss, having been brought before the Council, first retracted his obnoxious doctrines, but being still kept in prison, as his retractation was not considered to be sincere, he demanded a public audience, at which he declared that he had recanted only through a temporary weakness, and that he persisted in his master's doctrines; upon which he was also condemned to the stake, to which he went with the greatest serenity. Poggio Bracciolini, who was present at the tragical scene, bears full evidence, in his letter to Aretino, to the firmness of the victim; and so does Æneas Sylvius, afterwards Pope Pius II., in his 'Historia Bohemica.'

The Council had promised to occupy itself with a reform of church discipline, which was much wanted in that age; but it did little in that way, having been abruptly dissolved by the new pope Martin V. in April, 1418. The Council of Constance is one of the most notorious in the history of the church, and was one of the most numerous ever assembled. Lenfant has given a full and instructive account of all its proceedings, session after session. ('Histoire du Concile de Constance,' 2 vols. 4to, Amsterdam, 1727.)

The next general council is that of *Basle,* which, on account of its importance in the history of the Church, deserves more particular notice. The council of Basle was convoked by Pope Martin V. in 1430, in conformity to a decree of the council of Constance, session 39, which had provided that a new general council should assemble within five years. Pope Martin appointed Cardinal Julian Cesarini, his legate in Germany, to preside over the council. Soon after, Martin died (February, 1431), and his successor, Eugenius IV., confirmed Cesarini as president of the council. The first session, or meeting, took place in December, 1431, when Cardinal Julian opened the council by an eloquent speech, in which he exhibited the evils of the Church resulting chiefly from the relaxation of its discipline; and, having exhorted the fathers and the clergy in general to give the example of regularity and piety to their flocks, he stated the two great objects of the present council to be, one, the reunion of the Eastern and Western Churches, and the other, an effectual reform of the Church in general in all its members. The council then appointed its various deputations, or committees, to examine at length the matters laid before each of them and make their reports thereon, which were to be taken into consideration by the whole council assembled in session, and there put to the votes.

The second session of the council took place in February, 1432. In the interval between the first and second sessions it became known at Basle that Pope Eugenius intended to dissolve the council as likely to prove troublesome to him if allowed to sit much longer, and that he had actually framed the bull for its dissolution. In consequence of this, the council issed a decree declaring that it held its power immediately from Jesus Christ, the Head of the Church; and that every person, even the pope, was bound to obey its decisions in matters of faith, as well as for the extirpation of schism, and likewise for the reformation of the Church. Meantime the pope had issued his bull of dissolution. Cardinal Julian then wrote two forcible letters to Eugenius, maintaining the rights of the council, and asserting that according to the canons of the council of Constance, by which he himself, Eugenius, held the papal dignity, as successor to Martin V., who had been elected by that council after it had deposed Pope John XXIII., and the other claimants to the papal crown, the pope had no power of dissolving a general council once lawfully convoked and assembled, until that council had performed the task for which it had been convoked. The fathers sent likewise a synodal answer, of the same meaning, to the papal bull, in which they asserted that the pope, although the ministerial head of the Church, was not exalted above the whole mystical body of the Church, as that mystical body, even exclusively of the pope, cannot err in matters of faith, being under the inspiration of the Holy Ghost; whilst the pope, although the head of the Church, might err, as experience showed. The body of the Church represented in the general council had deposed popes who had erred in matters of faith, but no pope had ever assumed to condemn or excommunicate the whole body of the Church.

In the third session, April, 1432, the council summoned Eugenius to revoke the bull of dissolution, and to attend the council in person in three months' time, or to send persons with full powers to represent him.

In the fourth session, June, same year, a safe conduct was given to the Bohemian deputies who proposed to appear before the council to arrange matters for the religious peace of their country. Pope Eugenius being reported ill at the time, the council decreed that in case of his death, the council should not proceed to the election of his successor any where else but in the body of the council. Any other election was declared beforehand to be null and void.

In the fifth session, in August of the same year, three judges were appointed to examine questions of faith. The Bishop of Taranto, sent by Eugenius as his legatee, delivered a high flown speech, exalting the papal authority as the only fit judge of the place and time for the holding of councils, and he stated that as the pope could not then leave Italy, he offered to remove the assembly to any town in the Papal states which the fathers might fix upon. The council replied that to dissolve or remove a council lawfully assembled would be to renew schism in the Church, and would be contrary to charity and the inspiration of the Holy Ghost.

In the sixth session, September, the council decreed that as Pope Eugenius did not make his appearance, he should be declared "contumax" after being cited three times at the gate of the church.

In the seventh session, November, the decree of the fourth session was confirmed, forbidding the cardinals to hold a conclave, in case of the pope's demise, without permission from the council.

In the eighth session, December, a further delay of two months was granted to Eugenius to revoke his bull of dissolution, after which the council would proceed canonically against him. It was also decreed that any other council convoked elsewhere, would be a cabal and a schism, as there could not be more than one general council assembled at a time. The Bohemian deputies arrived at Basle in January, 1433. They laid before the council the demands of their constituents, namely the sacrament "sub utraque" for the laity; that the clergy should have no power over temporal things, and that the word of God should be preached fairly and freely. The council upon this appointed deputies to repair to Bohemia to confer upon these matters on the spot.

In the ninth session, January, 1433, the Emperor Sigismund having by letters patent taken the council and all its members under his especial protection, the council on its part declared that it would protect Sigismund from any arbitrary act of the pope against him.

Tenth session, February, 1433. The council was proceeding to declare Eugenius "contumax," but the emperor and Cardinal Julian interposed, and offered to write to the pope, upon which the council adjourned its proceedings.

Eleventh session, April same year, it was decreed that if the pope henceforth neglected to assemble a general council every ten years, as ordained in the ninth session of the council of Constance, the right of convocation should devolve upon the bishops without the pope's permission. The fathers likewise confirmed the decree of the council of Constance, by which a general council, once assembled, could not be adjourned, transferred or prorogued by the pope without the consent of two-thirds of the members. Meantime Eugenius had sent two legates to the council, with full powers; but the council would not admit them, as the pope had not revoked his bull of dissolution.

Twelfth session, July. The council summoned Pope Eugenius to revoke within two months' time his declaration of transferring the council to another place. It also passed several regulations of discipline, against simony, &c. Eugenius on his part abrogated by a bull the decrees of the council against himself, and declared the council to have been in error when it asserted its superiority above the pope.

Thirteenth session, September. At the request of the Duke of Bavaria another month was allowed to Eugenius before the fathers passed judgment upon him.

Fourteenth session, November. The Emperor Sigismund was present at the council. Three months were granted to Eugenius to revoke all his acts against the council.

Fifteenth session. Eugenius, having at length listened to the mediation of France, Burgundy, and other powers, revoked the bulls which he had launched against the council, and issued another bull according to the form sent to him by that assembly, in which he declared that although he had dissolved the council of Basle lawfully assembled, yet, in order to avoid dissension, he now declared that the council had been lawfully continued since its first beginning, and that he approved of all its decisions, and declared the bull of dissolution to be null and void. He then appointed four cardinals to preside in the council together with Cardinal Julian.

Sixteenth session, February, 1434. The letters of Eugenius were read in full council and presence of the Emperor Sigismund. The papal legates were introduced and incorporated with the council.

Seventeenth session, April. The legates were made to swear to support the dignity of the council, and to observe its decrees as well as those of the Council of Constance, and that their authority should be dependent on that of the council and not coactive with or compulsory upon the council.

Eighteenth session, June. The council confirmed the decrees of the fourth and fifth sessions of the Council of Constance. John, Patriarch of Antioch, read a thesis in favour of the superiority of the general council above the pope.

Nineteenth session, September. Conferences with the ambassadors of John Palæologus, emperor of Constantinople, concerning the projected union of the Eastern and Western churches. Legates appointed by the council to proceed to Constantinople. The council decreed that in every university there shall be professors of Hebrew, Arabic, Greek, and Chaldæan.

Twentieth session, January, 1435. Decrees of reform of church discipline, penalties against concubinarian priests, &c.

Twenty-first session, June. Decree against the "annates," or first fruits, and other payments and fees exacted by the court of Rome. Three years of undisturbed possession of a benefice, obtained by legitimate title, to be considered as affording a prescriptive title to the possessor. Several decrees on public worship and other matters. Pope Eugenius remonstrated strongly against the suppression of the "annates," urging that the council ought at least to make compensation for the support of the Holy See. Cardinal Julian's reply to the pope's remonstrances.

Twenty-second session, October. Condemnation of a book written by an Austin friar, who had ascribed some attributes to the human nature of Christ which properly belonged to his divine nature.

Twenty-third session, March, 1436. Decrees concerning the free election of the pope, his profession of faith, the number of cardinals reduced to twenty-four, &c. All reserved benefices, mandates, and other grants applied by the popes to their own profit, declared null and void.

Twenty-fourth session, April. The legates of Eugenius urged the fathers to fix upon a town where to assemble a new council, in order to meet the Eastern emperor and his retinue and prelates, for the purpose of effecting the reconciliation of the two churches. A congregation was held in consequence, which was attended by 357 prelates, two-thirds of whom voted for the city of Basle, if the Greeks should agree to it, and if not, they proposed Avignon or some town of Savoy. A deputation was sent to Eugenius to entreat him to crown the labours of the present council by the reunion of the Eastern with the Western churches, and inviting him to come in person and expedite the necessary bulls. Eugenius, however, supported by a minority in the council, was for holding a new council in some town of Italy, and many months elapsed in fruitless negotiations upon this subject.

Twenty-fifth session, May, 1437. The council decreed that the œcumenic council for the union of the two churches should sit either at Basle or at Avignon. Most of the fathers did not wish to go to Italy, where they would have been too much in the power of the pope. A division then occurred in the assembly. A minority joined the papal legates, and made a decree by which they assumed the authority and name of a council, and transferred the council to Ferrara. Eugenius hastened to issue a bull which confirmed this decision, and immediately caused a squadron of galleys to be equipped at Venice, to proceed to Constantinople with three papal legates, for the purpose of bringing the emperor and the eastern prelates to Ferrara. The council of Basle, that is to say the majority of that assembly, which had kept together, sent likewise galleys for a similar purpose, but they were too late, and the emperor repaired to Venice with the papal legates on board the Venetian galleys. Cardinal Julian, who was still at Basle, proposed to the council to send a deputation to Venice to receive the emperor on his landing, and, by explaining to him how matters stood, to endeavour to bring him to Basle. The fathers, however, hesitated and lost time. Up to this period the council of Basle is considered by most Roman Catholic theologians, to have been truly œcumenic and legitimate, as Pope Eugenius had solemnly acknowledged it as such since November, 1433, and had since acted in union with it by means of his legates. But some ultramontane divines, and Holstenius among the rest, controvert the authority of the council altogether. Pope Nicholas V. however, who succeeded Eugenius, in his bull beginning "Ut pacis," dated Spoleto, July, 1449, speaks of the council of Basle with respect as a council, and not as a conciliabulum, and Eugenius himself in his letters to his legates in Germany, dated Rome, August, 1446, inserted in the Annals of Raynaldus, speaks of the general councils of Constance and Basle, as being by him acknowledged and venerated, without prejudice, however, to the right and pre-eminence of the Holy See.

The council of Basle, in its twenty-sixth session, July, 1437, again summoned Eugenius to appear before it, and Eugenius answered by a bull for the dissolution of the council, appointing the meeting of a new council, to which he invited all Christian prelates, and forbidding under heavy canonical penalties, the making of any more synodal acts at Basle, after the period of thirty days, which were to be employed in winding up the negotiations with the Bohemian deputies. King Charles VII. of France forbade his bishops to repair to Ferrara.

In their twenty-seventh session, September, the fathers at Basle declared null and void the creation of two cardinals recently made by Eugenius.

In the twenty-eighth session, October, the period assigned to Eugenius for his appearance being expired, the fathers declared him "contumax," and resolved to proceed canonically against him. Eugenius at the same time issued a bull, transferring the council to Ferrara. In his letters to his legates in Germany he speaks of the council of Basle as a legitimate assembly, until the order for transferring it to Ferrara.

In the twenty-ninth session, October, the fathers rejected the bull of transfer to Ferrara, and assigned their reasons for it.

In January, 1438, one Cardinal Nicholas, Eugenius's legate, opened the new council at Ferrara. Cardinal Julian, who still remained at Basle, quitted that town with four other prelates, and joined the council of Ferrara. The council of Basle was declared henceforth null, and all its future acts were declared void. Several theologians date from this epoch the termination of the legality of the council of Basle. That assembly, however, went on holding its sessions for five years longer, and a schism in the Church was the result. The council of Basle deposed Eugenius in 1439, and elected Amadeus VIII. of Savoy, by the name of Felix V. These measures, however, were discountenanced by the great majority of the catholic world; France, England, and Germany disapproved of them. Most of the bishops withdrew from Basle, and their places were filled up by archdeacons, friars, provosts, and doctors, and other churchmen not of episcopal rank. From that period it is impossible to consider the council of Basle any longer as œcumenic. The last session of this self-styled council of Basle was held in May, 1443, when it decreed that within three years a council, or rather a continuation of the council, should be held at Lyon. It, however, met ultimately at Lausanne, in 1449, when Felix having abdicated, the remaining fathers of the council of Basle made their peace with Nicholas V.

In the collection of the Acts of General Councils, handsomely published in Greek and Latin, by order of Pope Paul V., 'Conciliorum generalium Ecclesiæ Catholicæ,' 4 vols. folio, Rome, 1628, the council of Basle is altogether omitted, but that of Constance is inserted. The following writers have treated especially of the council of Basle:—Æneas Sylvius Piccolomini (afterwards Pope Pius V.), who was for a time secretary to the council, in his 'Opera,' which also contain the two celebrated epistles of Cardinal Julian to Pope Eugenius, maintaining the paramount authority of the council; le Père Alexandre, a Dominican, 'Dissertationes de Conciliis Senensi et Basiliensi,' in the eighth volume of his 'Historia Ecclesiastica,' Paris, 1714, and Venice, 1749; Richer 'Responsio Synodalis data Basiliæ, Oratoribus D. Eugenii P. P. IV., in Congregatione Generali III., Non. Septemb. 1432: De Auctoritate cujuslibet Concilii generalis supra Papam et quoslibet Fideles, pars præcipua, et in eam Commentarius,' Coloniæ, 1613; Lenfant, 'Histoire de la Guerre des Hussites et du Concile de Basle,' which refers chiefly to the transactions of the Bohemian schismatics and their negociations with the Council of Basle, on particular points of rite and discipline; Richard 'Analyse de Conciles.'

Ferrara, Council of, was attended by Pope Eugenius, the Emperor John Manuel Palæologus, the patriarch of Constantinople, Mark, archbishop of Ephesus, and about twenty more eastern bishops. The discussions between them and the Latin prelates turned first upon the dogma of the proceeding of the Holy Ghost and the word "filioque" said to have been added by the Latins.

In 1439 the council was transferred to Florence, and the discussions were continued. The two parties effected a reconciliation, excepting Mark of Ephesus, upon the dogma of the Holy Ghost, that of purgatory, and the supremacy of the pope, which the Greeks acknowledged, "saving the privileges and rights of the patriarchs of the East." The act of union was signed by the vicars of the patriarchs of Alexandria, Antioch, and Jerusalem, and by several metropolitans, but it was soon after disavowed by the great body of the Eastern Church. [GREEK CHURCH.] The eastern prelates, about thirty in number, left Florence in August, 1439, to return to their country. After their departure, Pope Eugenius continued the council, although it could no longer be called general, the reunited Eastern Church being no longer represented in it. The fathers of Basle, who had deposed Eugenius, were declared heretical, as well as Felix V., who was declared to be a schismatic antipope. After several other decrees the Council of Florence was closed in April, 1442. The French and other divines do not recognise the authority of the Council of Florence, which however is fully acknowledged at Rome. The same may be said of the following:—

Lateran, the Fifth Council of, was convoked by Pope Julius II., in 1512, to oppose the acts of the pretended council of Pisa, when a certain number of prelates hostile to Julius had assembled under the influence of the king of France, then at variance with the pope. After declaring all the acts of Pisa null and void, and summoning the French prelates to appear at Rome, Pope Julius died in February, 1513, but his successor, Leo X., continued the council, and Louis XII., giving up the "Conciliabulum" of Pisa, sent in his adhesion to the council of Lateran. The French prelates, however, did not attend, under various excuses. The council continued assembled till March, 1517. It chiefly concerned itself with matters of discipline. Among others, it established a general ecclesiastical censorship on all printed books, under pain of excommunication. [Censorship of the Press.] It confirmed the concordat made at Bologna between Pope Leo and Francis I., concerning the sees and benefices of France, and annulled the previous pragmatic sanction promulgated by King Charles VII., conformably to the decrees of the councils of Constance and Basle. The concordat took away from the chapters the right of electing to vacant sees, and gave the nomination to the king, subject to the papal sanction and ordination.

Trent, the Council of, is the last œcumenic council of the Latin church, and is acknowledged as such by the Roman Catholic world, although some of its decrees in matters of discipline are not sanctioned by the laws of many states. [Trent, Council of.]

The principal collections of the acts of the councils are: Labbé and Cossart, 'Sacrorum Conciliorum nova et amplissima Collectio,' with additions by Coleti and Mansi, 31 vols. fol., Florence and Venice, 1759-98; 'Concilia generalia Ecclesiæ Catholicæ Pauli V. Pont. Max. auctoritate edita,' 4 vols. fol. Rome, 1628; 'Concilia Generalia,' edita a T. Merlino, 2 vols. fol., Cologne, 1530; 'Concilia Omnia, tam generalia quam particularia,' a Petro Crabbe, 2 vols. fol., Cologne, 1538-40; 'Collectio Regia maxima Conciliorum, seu Acta Conciliorum et Epistolæ Decretales, ac Constitutiones Summorum Pontificum ab anno Christi 34 ad 1714, studio Joh. Harduini, Soc. Jesu; cum novis indicibus,' 12 vols. fol., Paris, 1714-15.

There are also collections of national councils: 'Collectio Conciliorum Hispaniæ, diligentia Garsiæ Loaisa elaborata,' fol., Madrid, 1593; 'Concilia Magnæ Britanniæ et Hiberniæ a Synodo Verolamiensi, A.D. 446 ad Londinense, A.D. 1717, a D. Wilkins collecta,' 4 vols. fol., 1737; 'Sacra Concilia Ecclesiæ Romano-Catholicæ in Regno Hungariæ celebrata, ab anno 1016 ad 1734,' fol., Vienna, 1742; 'Concilia antiqua Galliæ, cum Epistolis Pontificum, Principum Constitutionibus, et aliis Gallicanæ rei Ecclesiasticæ monimentis, Opera et Studio T. Sirmondi,' 3 vols. fol., Paris, 1629; 'Collectio maxima Conciliorum omnium Hispaniæ et novi Orbis, cura et studio Jos. Saenz de Aguirre, editio altera novis additionibus aucta a Jos. Catalano, cum indicibus,' 6 vols. fol., Rome, 1753; 'Conciles de Toulouse, Béziers, et Narbonne, ensemble les ordonnances du Comte Raimond contre les Albigeois, par Arnaud Sorbin, D.D.,' 8vo., Paris, 1569; 'Atti dell' assemblea degli Arcivescovi e Vescovi della Toscana tenuta in Firenze, l'anno 1787,' 4to., Firenze, 1787; 'Atti e decreti del Concilio Diocesano di Pistoja dell' anno 1786,' 4to. Firenze, 1788; 'Salmon, Traité de l'etude des Conciles et de leurs Collections,' Paris, 1724.

Some of the old Spanish councils are very important, such as the Council of Iliberis, 303, which concerned itself chiefly with the morals of the faithful, exposed as they were to the bad example of their heathen countrymen. Its canons, to the number of eighty, have come down to us, which is not the case with most of the previous councils. Several of the councils of Toledo are also very important for the elucidation of Church history and controversy, especially on questions of discipline.

The Greek or Eastern Church, since its separation from Rome, has held its own general councils or synods under the presidency of the œcumenic patriarchs of Constantinople. [Greek Church; Russian Church.]

The Protestant and Reformed Churches have also held their councils or synods, such as Dort, Synod of. The Synod of Emden, in 1571, and that of Sandomir, for the Protestant churches of Poland; the general assemblies of the Scottish Church, and the convocations of the Church of England, are also a sort of national councils; but the Protestants in general do not admit the divine inspiration and consequent infallibility of the councils, whether general or national, though they acknowledge the doctrines propounded by the first two œcumenic councils of Nice and Constantinople.

COUNCILLORS. [Corporations; Municipal Corporations.]

COUNSEL, an abbreviation of counsellor, by which in England is understood a barrister. The phrase includes, of course, serjeants, Queen's counsel, and by courtesy comprehends those who, having kept twelve terms at one of the inns of court, have been permitted to practise under the bar. [Barrister.] The word has no plural number, and is used to denote either one or more counsel. The duty of counsel is to give advice in questions of law, and to manage causes for clients. They are styled common law, equity, or chamber counsel, according to the nature of the business they transact. They are supposed to plead gratuitously. [Advocate.] In the words of Mr. Justice Bayley, 1 Chit. R. 351, "they are to be paid beforehand, because they are not to be left to the chance whether they shall ultimately get their fees or not, and it is for the purpose of promoting the honour and integrity of the bar that it is expected all their fees should be paid when their briefs are delivered. That is the reason why they are not permitted to maintain an action for their fees." Counsel may be retained generally, that is, to advocate any cause in which the retaining party may be engaged, or specially with reference to a pending cause; and generally speaking, it is not optional for counsel to refuse a retainer; there are certain rules, however, by which their practice is regulated.

Counsel in a cause have the privilege of enforcing anything which is contained in their instructions and is pertinent to the matter in question, and are not bound to inquire whether it be true or false; they are also at liberty to make fair comments on the evidence adduced.

Formerly, in cases of felony, counsel for the prisoner were not allowed to address the jury on his behalf; they might, however, examine and cross-examine the witnesses, and argue points of law; but now by stat. 6 & 7 Wm. IV. c. 114, all persons tried for felony may make full answer and defence by counsel.

Counsel are punishable by stat. West. 1. 3 Ed. I., c. 28, for deceit or collusion, and, it is said, are so far under the jurisdiction of the judges, that in the event of malpractice they may be prohibited from addressing the court. They are certainly bound by the rules established by each court for the regulation of its own practice; and for professional or other misconduct may be disbarred by the inn of court to which they belong (Blackst. 'Comm.,' Mr. Kerr's ed., v. iii. p. 28.)

COUNT, through the French word *comte*, from the Latin *comes, comitis*, meaning companion. Considered in its original acceptation, this word might be translated by assessor, an officer who, during the Roman republic, was given as an assistant to the proconsuls or the proprætors sent out to govern the provinces. Cicero speaks of these comites in several passages of his works. Dion Cassius states that Augustus Cæsar called by that name all the officers of his imperial household. These comites pronounced judgment on all matters referred to them by the emperor, and their judgments had the same authority as the Senatus Consulta. The council of state instituted by Napoleon I. gives a very exact idea of the constitution of that court tribunal. Like the council of state, the latter was invested with judicial, legislative, and executive power. The emperors of the East followed the example of those of the West, with this difference only, that the comites created by Augustus and his successors were the counsellors of the emperor, and the title belonged to the office and not to the person; whilst at the court of Constantinople it was quite the contrary. The nomenclature of these counts fills a considerable place in the Glossary of Ducange. The *comes marcarum*, counts of the frontiers, which were formerly called *marches* (a denomination still in use in the papal states), took subsequently the title of *marquis*; an innovation which raised long and serious discussions among the learned in feudal right and court etiquette.

Under the first two races of the Frank kings, the counts were, as under the lower empire, officers of various degrees. The count of the palace was the first dignity in the state, after the *maire* of the palace. He presided in the court royal when the prince was absent, and possessed sovereign jurisdiction. He also exercised a great influence in the nomination of the king's delegates, who, under the title of counts, administered the provinces. A count had the government of a small district, often limited to a town and its dependencies. He was at the same time a judge, a civil administrator, and a military commander. In case of war, he led in person the contingent of his county to the army. The learned Dutillet, in his 'Recueil des Rois de France, de leur Couronne, et Maison,' &c., expatiates on the functions of ancient counts. With the progress of time, the counts, as well as the other officers appointed to govern the provinces, the towns, and the frontiers, succeeded in rendering their places hereditary, and in making themselves sovereign masters of the districts of which they had only been created removeable and revocable administrators. At first they contented themselves with securing the reversion to their sons, then to their collateral heirs, and finally they declared those places hereditary for ever, under Hugh Capet, the son of Robert, count of Paris, who himself only obtained the throne partly in consequence of that concession. It was feudalism that introduced inheritance instead of election as a permanent rule in political successions. The supreme chief of the ancient Franks, *koning* (Lat. *rex*), was a magistrate, and as a magistrate he was elected, although always from the same family. The inferior chiefs, *heri-zoghe, graven, rakhen-burghe* * (Lat. *duces, comites, judices*), were also elected.

The term "count" is now become in France a mere title, conferring no political importance. In the papal states, as well as in those of

---

* *Heri-zoghe*, in its proper acceptation, means *leader of an army*, from the word *heer*, army, and the verb *ziehen*, to lead. *Grave, graf, gheref*, means, in all the Germanic dialects, the authority of a secondary magistrate. *Rakhen-burghe* means notable persons; they are employed as judges and guardians of public order.

Austria, it may be bought with sums of money not at all considerable; and in the other monarchical states of the continent, it is granted as a mark of imperial or royal favour.

The title of *earl*, or, as it was often rendered in Latin, *comes*, companion, is of very high antiquity in England, being well known to the Saxons under the name of *ealdorman*, that is to say *elder-man*, and also *shireman*, because each of them had the government of a distinct *shire*, or, as it is now generally called, *county*. The sheriff, under his latinised name, is called vice-comes, or viscount, which term [VISCOUNT] is now one of the titles of rank in the British peerage. The term count seems not to have been used in England as a title of honour, though the wives of earls from a very early period have been addressed by the title of countess. The king, in mentioning an earl in any writ or commission, usually styles him "trusty and well-beloved cousin," a peculiarity at least as ancient as the reign of Edward III.

COUNT. [DECLARATION; PLEADING.]

COUNTER-APPROACH is the term applied in fortification to any small work thrown up by the besieged to look into or enfilade any of the besiegers' approaches. As its name indicates, it is generally made by running out a trench from one of the outworks to some advantageous rising ground in its vicinity, or to such a position that a battery formed in it may enfilade some of the enemy's boyaux of communication which have been directed clear of the main works. By these means, an active, vigorous, and energetic defender may prolong his defence considerably, as each counter-approach entails much loss of time to a besieger, either in taking it or making fresh communications. In no siege, perhaps, in history has this plan been followed out to so great an extent and with such great success as at Sebastopol: there a force as large, and for a time much larger, than the besiegers, with an unlimited supply of *materiel*, was enabled to push out counter-approaches as fast as the allies could advance their trenches; and thus the besiegers were every now and then surprised and stopped by finding works rapidly constructed and armed on their flank and almost in their rear, entailing great loss of time while the works were extended to the flank and fresh approaches made to take these counter-approaches. Thus was it with the Mamelon, and with what were called the White Works, which cost the French many thousands of lives to take.

COUNTER-ARCHED REVETMENTS, or *Revêtments en Décharge*. The simple or plain revetment consists, as described under BASTION, of a retaining wall of masonry, strengthened at intervals by counterforts, supporting the earth of the rampart which rests against it; in the counter-arched revetment the mass of earth does not, however, rest against the main wall, which is therefore made for the escarp only 5 feet, and counterscarp only 3 feet, thick; and the counter-forts, 5 feet thick and 16 feet from centre to centre, extend about 8 feet back, and rising about 7 feet above the foot of the revetment, are then covered and connected by arches turned from one to the other, which support the earth of the parapet and thereby form a bomb-proof cover, communication being obtained along the whole extent by openings cut in the piers. With loopholes cut in the front wall, counter-arched revetments are further useful in affording a defence for the ditch by a low musketry fire. The earth of the rampart is retained either by arches turned from end to end of the counterforts with their concavity to the front wall, or by a flat wall connecting the piers, or without anything at all by the earth being allowed to assume its natural slope. Hence a further advantage of the counter-arched revetment is, that the besieger, after breaching the front wall, must break through these counter-arches by breaching or mining the piers before he can make a practicable breach. To make the destruction of the piers more difficult, and to hinder the earth falling to a slope, even when the outer revetment is breached, the counterforts are connected in portions of Carnot's system by two walls 1 foot 6 inches thick placed at 11 and 18 feet from the back of the escarp, and arched convex towards the rear. The compartments formed by this network of walls are then filled with earth. [REVETMENT.]

COUNTERFORT, an addition to the thickness of a quay or of an abutment wall, made for the purpose of increasing the dynamical resistance of the latter; and a *counterfort* differs from a *buttress* in this respect, that the former is placed on the inside of the wall, where it is hidden by the earthwork or other backing; whereas the latter is apparent, and is often made to form part of the architectural character of a building. The philosophical principles to be observed with either of these portions of a building are however the same, and they may be stated to be, that they should distribute the effort over the greatest possible area, and also as far as possible decompose its action, in such a manner as to bring it ultimately upon the base of the additional structures, which can more easily be rendered perfect than the base of the whole wall. Counterforts, when used to strengthen the abutments of a bridge, must present a moment of dynamical resistance which shall be more than sufficient to compensate for the deficiencies of the abutment itself; and this may be ascertained by supposing that the mass of the counterfort is applied in a thin sheet along the inner side of the wall, or, in other words, that the mass of the wall is increased by the whole mass of the counterfort. But evidently this is an unfavourable, whilst it is a safe mode of calculation; for it leaves entirely out of account the influence of the leverage of the projection. When counterforts are applied to the inner faces of quay walls they act by splitting up into portions, as it were the effort of the earthwork behind them nearly as much as they do by increasing the dynamical resistance of the walls themselves. Great precautions must be adopted in building such counterforts to ensure the sound binding together of the masonry of the respective parts of the structure.

COUNTER-FORTS, in military architecture, are buttresses of brick or stone built against the revetment walls, by which the outward pressure of the rampart, or of the natural ground on the opposite side of the ditch, is resisted. The rectangular portions at N and M, *fig.* 2, BASTION, are counter-forts so situated. They are intended to increase the strength of such walls, and are formed between them and the earth which the walls retain. Their depth is usually equal to the mean thickness of the revetment, and they are placed at intervals of about 18 feet from each other, along the walls. They are sometimes connected together by counter-arches. [REVETMENT.]

COUNTER-GUARDS are outworks occasionally constructed on the exterior of the bastions or ravelins of a fortress in order to retard the formation of a breach in either of those works.

The counter-guard is in general merely a line of rampart surmounted by a parapet, and broken in direction so as to form two faces parallel to those of the work which it covers; it has less relief than the interior work, in order that the fire from the latter may pass over it, and when taken may not afford the enemy in any lodgment which he may form in it the power of seeing into the main works. Its breadth in rear of the parapet should not exceed about 18 feet, that, while there may be room for the defenders, the enemy may not have sufficient space for the establishment of a battery on its *terreplein*; and consequently, that he may not be able to breach the bastion or ravelin till, by mining or otherwise, he has detroyed the counter-guard.

When counter-guards are constructed in front both of a bastion and of the collateral ravelin, the interval between their extremities unavoidably leaves a face of one of these works exposed; and, as a breach in the former would be more fatal to the defenders than one in the latter work, the lengths of the counter-guards must be determined by the condition that the exposed face be that of the ravelin.

What are called counter-guards in the second and third systems of Vauban are, properly, bastions detached from the line of rampart called the enceinte. [See the work marked V, in *fig.* 3, BASTION.]

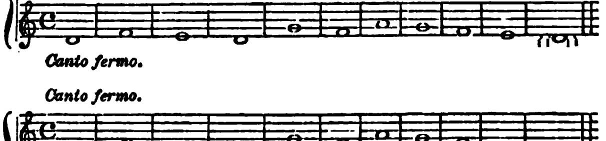
Counter-guards always, however, have the disadvantage, when taken, of providing a safe large retired *place d'armes* in their ditches, where the attacking officer may collect his assaulting column close to the breach.

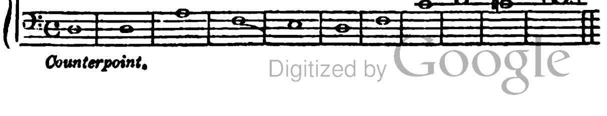
COUNTERMINE. [MINES, MILITARY.]

COUNTERPART. [DEED.]

COUNTERPOINT, in music (*contrapunctum*), is a term now synonymous with harmony [HARMONY], and nearly so with composition; but the latter implies more of invention, of imagination, particularly as relates to melody, than counterpoint imports. Counterpoint in its literal and strict sense signifies *point against point*. In the infancy of harmony, musical notes or signs were simple points, or dots, and in compositions in two or more parts were placed on staves, over, or against, each other. Subsequently, the term was applied to the parts added to a given melody, such melody taking the name of *cantus-firmus*, *canto-fermo*, or plain-song. [PLAIN-SONG.] Viewing it in this sense, the Padre Martini wrote his very elaborate and justly-celebrated 'Saggio di Contrappunto sopra il Canto-Fermo' (1774), a work to which we refer every student who wishes to enter deeply into the subject. But Zarlino, in his 'Institutione Harmoniche' (1589), ranks counterpoint as the principal part ("*soggetto principale*") in airs, &c., written in two parts. And many writers consider the word as applying generally to composition in parts, among whom are the learned Dr. Pepusch, the acute Spanish jesuit Eximeno, the industrious Dr. Lichtenthal, &c.; so unstable is musical language, so ill defined are musical terms!

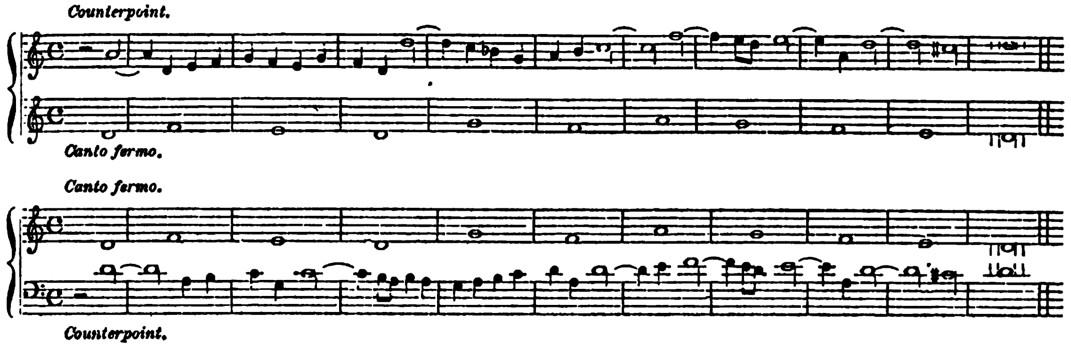
Counterpoint is divided into *Simple*, *Florid*, or *Figurate*, and *Double*. Simple counterpoint is a composition in two or more parts, the notes of each part being equal in value to those of the corresponding part, or parts, and concords. Johann Fux, Kapellmeister to the emperor Charles VI., in his 'Gradus ad Parnassum' (1725), furnishes us with the following examples of this species, calling one part *cantus firmus*, or the *canto fermo*, the other *contrapunctum*, or counterpoint, and taking each in turn as the melody. We have here substituted the treble for the C clefs.



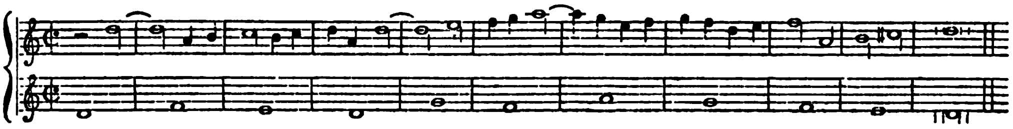


In *Florid Counterpoint* two or more notes are written against each note of the subject, or *canto fermo*, and discords are admissible. Examples from Fux.

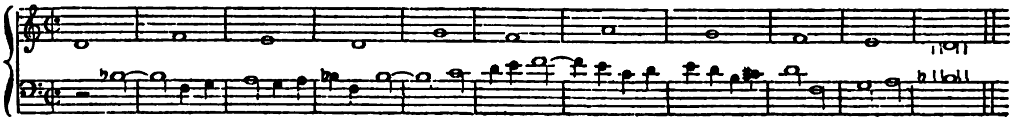
Double Counterpoint, says the German theorist whose examples we have quoted, "is a species of composition in which any of the parts may be transposed into the tenth above or below, omitting some notes, the subject remaining stationary." Or, in other words, it is an inversion of the parts, so that the base may become the subject, the subject the base, &c., thus producing new melodies and new harmonies, "in an artificial and wonderful manner," adds Pedro Cerone, who seems to have been quite delighted with the contrivance; at a period, however (1613), when subtleties of all kinds were more valued than in the present day. Fux gives the subjoined examples of double counterpoint, from which it will be seen that this is little more than an extension of florid counterpoint. In the first example the *canto fermo* is the base, the counterpoint the treble. In the second, the *canto fermo* is the upper part, while the counterpoint is transposed a tenth lower, and becomes the base. In the third, the *canto fermo* and counterpoint remain as in the first example, while the latter, transposed a tenth lower, is adopted as a base, as in Ex. 2; and thus is formed a composition in three parts.



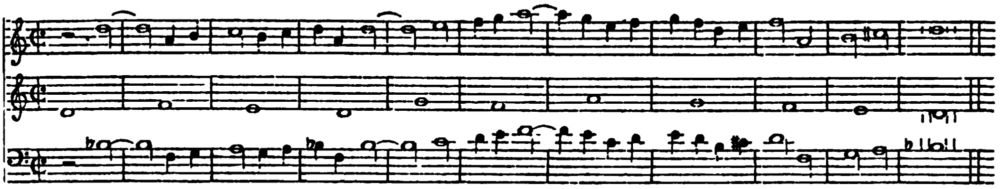
Ex. 1.



Ex. 2.



Ex. 3.



The study of Counterpoint is necessary as part of the education of a good musician, though now much neglected; it has, nevertheless, been sometimes carried to such a length as to become pure pedantry. For the principal rules of Counterpoint,—and also for some brief remarks on the question, "whether the art of writing in parts," was understood by the ancients, see HARMONY.

COUNTERPOISE is, generally, a mass of brass or iron so disposed as to keep a part of some instrument or machine *in equilibrio*.

The instruments employed in practical astronomy are generally mounted so that their centres of gravity are supported, in which case they require no counterpoise; but a reflecting circle, for example, when placed in any position except one which is horizontal, has its centre of gravity on one side of the pillar which supports it; and a mass of brass, so connected with the axis of the circle as to be always on the side of the pillar which is opposite the latter, serves the purpose of keeping the instrument steady.

A transit instrument, or a mural circle of considerable magnitude and weight, whose pivots would press heavily on their supports, is sometimes provided with counterpoises, one for each point which is to be relieved; this is applied at one end of a lever which is supported by the pillar or stand of the instrument, the other end being connected, near the pivot, with the axle; and thus the pressure is diminished or wholly removed.

A bridge which is capable of being turned on horizontal joints at one of its extremities [DRAWBRIDGE] usually has its weight relieved, or almost wholly removed, by a counterpoise, so that the machinery employed to raise it has little except the resistance arising from friction to overcome. The counterpoise is at one extremity of a chain, which passes over a pulley at the top of a pillar, and is attached at the other extremity to some part of the bridge.

Now, since a drawbridge, in being raised or lowered, exerts on the suspending chains a strain which increases as the bridge declines more from a vertical position, it is necessary, in order that this strain may be always *in equilibrio* with the constant weight serving as a counterpoise, that the latter should move on a surface whose figure is determined consistently with that condition. The rules for the resolution of forces give expressions for the strains to which the two parts of the chain are subject in the directions of their lengths; and, making these equal to one another, there is obtained an equation which may be shown to be that of an epitrochoid; such, consequently, is the figure which should be given to the surface on which the counterpoise is to slide. It should be observed that, in the investigation, the effective weight of the drawbridge is not its absolute weight (acting at the centre of gravity); but is equal to this latter weight diminished in the inverse ratio of the distances of the fulcrum, or joint, from the centre of gravity and from the point at which the chain is attached to the bridge, generally the opposite extremity of the latter.

If the pulley over which the chain passes is close to the elevated extremity of the bridge when the latter is in a vertical position, the length of the chain will, of course, be equal to the diagonal of a square of which the length of the bridge is one side; then, a circle whose centre corresponds to the joint of the drawbridge, and whose radius is the whole length of the chain, being supposed to revolve on the circumference of a fixed circle of equal radius; a point supposed to be on the produced radius of the revolving circle, or epicycle, at a distance from its centre equal to the difference between twice the length of the radius, or chain, and the length of the bridge will, by revolving with the epicycle, describe the required curve.

The great telescope of Lord Rosse, at Parsonstown, Ireland, turns upon a joint at its lower extremity; and, being intended to decline from a vertical position both towards the north and the south, it is provided with two counterpoises, in order to facilitate its elevation or depression. One of these weights is on a chain which is attached, at one extremity, to a point near the object end of the telescope, and, at the other, to a fixed point at the top of the wall; this point being so situated that, in elevating the telescope, the weight descends, and describes, by its gravity, a circular arc coinciding nearly with the proper epitrochoid. The other weight is at the end of a lever projecting horizontally, from the lower extremity of the telescope, when the latter is in a vertical position; and then, consequently, it acts with the greatest power; its action diminishes, by the lever being elevated or depressed, as the telescope declines from the vertical towards the north or south.

COUNTERSCARP, is that side of the ditch, about a fortress, which is opposite to the ramparts. The part which is in front of the salient angle of a work is in the form (on the plan) of a circular arc having the vertex of that angle as a centre; and, if the ditch be that of an outwork, the direction of the counterscarp is generally parallel to the rampart; the counterscarp of the main ditch is in the direction of a line which is a tangent drawn to the arc from the shoulder of the collateral bastion. [See the lines above F G, G E, *fig.* 1. BASTION.] This is intended, since the length of the flank is greater than the breadth of the ditch at the said angle, to allow the whole fire of the flank to be directed along the main ditch; and Cormontaingne suggests that the tangent should be drawn from the interior side of the parapet at the shoulder angle, in order that the fire of the man stationed there may more accurately graze the wall of the counterscarp.

In most systems of fortification the counterscarp is retained by a vertical wall of masonry, similar to that of the escarp [ESCARP], in order to render the descent of the enemy into the ditch a difficult operation, requiring mining or other operation to destroy the wall, and thereby entailing delay: the defence of the covered way is also thereby prolonged, since the enemy who may have entered it at one place is unable to spread along it on account of the traverses which are constructed across it. Carnot, however, recommends that the counterscarp side of the ditch should be formed in a gentle slope rising from the bottom to the level of the natural ground, in order that the garrison may with facility make those great sortics which he considers as one of the most powerful means of defence.

COUNTERVALLATION, a chain of redoubts executed about a fortress in order to prevent the sorties of the garrison: the works are generally unconnected with each other, but sometimes they are united by a continuous line of parapet. It has happened, during the continuance of a siege or blockade, that the investing corps has been menaced by an army coming up to relieve the fortress; in which case, when it is intended to act on the defensive without abandoning the siege, a chain of redoubts is constructed to strengthen that corps on the exterior: this is called a circumvallation; and originally, like the interior chain, it entirely surrounded the fortress.

According to Thucydides, the town of Platæa, when besieged by the Lacedæmonians, was surrounded by a line of palisades to prevent the egress of the garrison; and subsequently a circumvallation was added. At the siege of Alesia, the countervallation executed by Cæsar consisted of a rampart of earth, 12 feet high, which was surmounted by a parapet, probably of stakes, and by turrets, at the distance of 80 feet from each other. A triple ditch was formed between this line and the town. The Roman army was encamped beyond the line, and enclosed by a circumvallation of similar form; the latter was 14 miles in circumference. It is related in the continuation of the history written by William of Tyre, that, at the siege of Acre by Richard I. of England, the defenders made a sortie, and having forced the agger, began to plunder the camp; and it is added, that Saladin, being in the neighbourhood with an army, made a night attack on the lines: these circumstances sufficiently indicate that both countervallations and circumvallations were then in use.

The long duration of ancient sieges rendered such works indispensable; but the use of artillery having greatly abridged the time to which the defence of a fortified place can be extended, they have become of less importance, and, in fact, it is only when the garrison is strong and the quarters of the besieging army are separated by the obstacles of the ground, that any works are considered necessary; and, in this case, instead of continuous lines of palisades and high towers of wood, a few simple redoubts and breast-works of earth are constructed at intervals. In general, the besiegers are protected by an army of observation in the field, when any effort on the part of the enemy to raise the siege is apprehended.

The siege of Sebastopol may seem at first sight to contradict the statement of works of circumvallation being little used in modern sieges, for there numerous and powerful works were thrown up to protect the besiegers' army from the attacks of the besieged, and indeed the want of them was felt at Inkermann; but it must be remembered that this could hardly be termed a siege in the strict sense of the word, but rather the attempt of one army to dislodge another equally powerful and, at times, more numerous opponent, from a strongly fortified position with supplies and *matériel* of every description close at hand. In consequence of which, and of the non-investment of the place, while the whole disposable force of the allies was occupied in carrying on the attack, works were necessary to protect their flanks and rear from the sudden sorties of the disposable Russian forces on any weak and unguarded points.

COUNTY. [SHIRE.]

COUNTY COURTS. The whole jurisdiction in civil causes of the old *schyremote*, or County Court, has been transferred to the new County Courts, first established for the recovery of claims not exceeding 20*l.* in amount, in 1846, but whose jurisdiction has since been considerably extended.

These tribunals were intended, not only to bring justice to every man's door, but also to supply the place of a great variety of inferior courts, established in different localities by as many different Acts of Parliament, obtained for that purpose. These Courts of Requests, or Courts of Conscience, as they were called, were intended solely for the recovery of small debts, and were consequently abolished when the new County Courts were established.

The County Court may entertain suits for the recovery of all debts, damages, and demands, legacies, and balances of partnership accounts, where the sum sued for does not exceed 50*l.* If the parties consent in writing, claims to any amount may be determined; but the court has no jurisdiction (unless the parties consent in writing) in any action in which the *title* to real property or in which the *validity* of any bequest under a will or settlement, may come in question; nor in any action for a malicious prosecution, for libel or slander, or seduction.

The crown may sue in this court for duties and penalties not exceeding one hundred pounds, the judgment in such cases being final. An action again may be brought in it against a custom-house officer, in respect of any illegal seizure of vessels or goods, where the damages do not exceed fifty pounds; but in this case there is an appeal, as in an ordinary action (16 & 17 Vict. c. 107). Questions between the crown and any party liable for Succession Duties (not exceeding fifty pounds) may also be determined in this court; the decision of the judge in such cases also being final (16 & 17 Vict. c. 51).

The County Courts are essentially *local* courts, for to give jurisdiction the defendant must reside within the district of the court, at the time of the action being brought. By leave of the court an action may be brought where the cause thereof arose within its district, in cases in which the defendant has dwelt or carried on business in such district within six months. The court has also jurisdiction to give a landlord possession of premises of which the rent does not exceed 50*l.*, and no fine has been paid, where the tenant's term has determined, or he has received notice to quit, orwhere the rent is half a year in arrear.

Its jurisdiction in testamentary matters is explained elsewhere. [PROBATE.] The County Court has an exclusive jurisdiction in determining the claims and disputes of the members and officers of Friendly Societies, Industrial and Provident Societies, and of Literary and Scientific Institutions (18 & 19 Vict. c. 63, s. 41; 15 & 16 Vict. c. 31, s. 8, the Literary and Scientific Institutions Act, 1854), and in the appointment of trustees to, and the regulation of, all charities within the district of the court, of which the gross annual revenue does not exceed 30*l.* [CHARITIES.]

A suit is begun by the entry of a plaint at the office of the court, which sets out the names of the plaintiff and defendant, and the nature of the action. Thereupon a summons is issued, a copy of which is served on the defendant by one of the bailiffs of the court, requiring the defendant to appear; which he must do at the court to which he is summoned, or have judgment given against him. If defence is made, the matter in dispute is, on the trial, inquired into, and disposed of summarily by the judge; who is to decide all questions, as well of fact as of law, unless one or other of the parties has demanded a jury for the trial of matters of fact: for in actions for sums above 5*l.*, a jury of five may be obtained as of right; in this case the facts are to be tried by the jury.

In actions for more than 20*l.*, an appeal lies to either of the superior courts of law at Westminster, against the decision of the judge in matter of law, or in the reception or rejection of evidence. No appeal lies against his decision in matters of fact.

The court, which is held once a month, is a court of record. On its judgment execution may be issued against the goods of the unsuccessful party. If he has no goods, but has the means of paying, and refuses to do so, he may be punished, after inquiry into his circumstances, by imprisonment for a period not exceeding forty days; or the judgment (if for more than 20*l.*) may be removed into one of the superior courts, and enforced there by the ordinary process of execution.

To encourage suitors to resort to this court, the plaintiff in the superior courts (in suits in which they have concurrent jurisdiction) does not in general obtain costs in actions of *contract* where he recovers less than 20*l.*, and in actions of *tort* where he recovers no more than 5*l.*, unless the judge who tries the cause certifies for costs, or it appears that there was sufficient reason for bringing the action in the superior court.

Previously to the establishment of the County Courts, the Courts of Bankruptcy had, under the 'Protection Acts,' jurisdiction to grant to any person who was *a trader* owing less than 300*l.* in all, or who was *not a trader* within the bankrupt laws, protection from all process. This jurisdiction was, by the statute 10 & 11 Vict. c. 102, vested in the County Court, and the Court for the Relief of Insolvent Debtors, in London. [PROTECTION ACTS.] In the County Court, also, may now be tried all actions of replevin. [REPLEVIN.] The judge has also power to grant a warrant for the arrest of an absconding debtor, and by statute 17 & 18 Vict. c. 104, to direct a vessel which has caused injury by collision or otherwise to another vessel to be detained until satisfaction is made for the injury, or security given to abide the event of legal proceedings.

The nature and jurisdiction of this court have been described thus fully, in consequence not only of the recent erection of these tribunals, but of the extent and variety of the powers vested in them, and the important position they have taken in the estimation of the people. (Blackstone's 'Commentaries,' Dr. Kerr's edit., vol. viii., p. 88.)

COUNTY RATE. County rates are taxes levied for the purpose of defraying the expenses to which counties are liable. They are levied either under the authority of acts of parliament, or on the principle that as duties are imposed upon a county there must be a power to raise the money for the costs incurred in the performance of such duties.

The ancient purposes of the county rate "were to provide for the maintenance of the county courts, for the expenses incidental to the county police, and the civil and military government of the county; for the payment of common judicial fines; for the maintenance of places of defence (sometimes, however, provided by a separate tax common to counties and to other districts, called *burgbote*), prisons, gaols, bridges (when these were not provided for by a separate tax common to counties and to other districts, called *brukbote*), and occasionally high roads, rivers, and watercourses, and for the payment of the wages of the knights of the shire. Additions to these purposes, some occasional and some permanent, were made from time to time by statutes. The king's aids, taxes, and subsidies were usually first imposed on the county, and collected as if they had been county taxes. But the first statute defining any of its present purposes (though now repealed as to the mode it prescribes for imposing the tax) was passed in the 22 Henry VIII. From that time up to the present new purposes have constantly been added, and new and distinct rates were constantly created for purposes of comparatively little importance, and to raise sums of money quite insignificant in amount." ('Report on Local Taxation,' by the Poor Law Commissioners.)

The assessment and collection of separate county rates was not only very inconvenient and troublesome, but so expensive that the charge of collection and assessment frequently exceeded the sum rated. For remedying this evil the 12 Geo. II. c. 29, was passed, whereby justices of the peace at general or quarter sessions were enabled to make a general rate to answer the purpose of the distinct rates previously leviable under various acts of parliament for the purposes of bridges, gaols, prisons, and houses of correction, such rate to be assessed upon every town, parish, and place within the county, to be collected by the churchwardens and overseers, along with the poor rates of every parish, and paid over to the high constable of hundreds, by them to treasurers appointed by the justices, and again by them to whomsoever the justices should direct.

Various acts amending the above statute were passed, but the whole law was consolidated, and the former statutes repealed, by the 15 & 16 Vict. c. 81. Under that statute, courts of quarter sessions appoint a committee of justices for the purpose of preparing and altering from time to time, a basis or standard for fair and equal county rates, founded on the value of property rateable to the relief of the poor, returns for that purpose being laid before the committee by overseers and other parish officers. The basis, being approved by the committee, is laid before the court of quarter sessions, who, after public notice, may confirm it with or without amendment, or refer it back to the committee. Overseers have a right of appeal against the basis on the ground of inequality. The basis being settled, the court of quarter sessions from time to time directs a county rate to be made according to this basis, for all the purposes to which such rate is made liable by law, expressing the amount on each parish, and against this rate parishes and individuals may appeal. The rate is collected by the overseers under precepts sent by the justices to the guardians of every union, or to the high constable of a hundred, and the amount is paid over to the county treasurer (or by the 21 & 22 Vict. c. 33, to the divisional treasurer), who is required to publish an annual abstract of his receipts and expenditure. This act extends to all places having separate commissions of the peace, and to all rates of the nature of county rates. Rates in the nature of county rates in boroughs are provided for by the Municipal Corporations Act (5 & 6 Will. IV. c. 76, as amended by subsequent statutes), and in boroughs not within the provisions of the Municipal Corporations Act, the rate is provided for by the 17 & 18 Vict., c. 71. It is to be observed that the police rate, although collected with the county rate, is made a distinct rate. (3 & 4 Vict., c. 88; 19 & 20 Vict. c. 69.)

The county rate is levied on the same description of property as the poors' rate, that is, on lands, houses, tithes impropriate, propriations of tithes, coal-mines, and saleable underwoods: the term "lands" includes improvements of lands, by roads, bridges, docks, canals, and other works and erections not included under the term "houses." Under houses are comprehended all permanent erections for the shelter of man, beast, or property. Mines, other than coal-mines, are exempted, and the exemption extends to limestone and other stone quarries, or to other matter that is obtained by quarrying. The county rate is to be assessed upon parishes "rateably and equally according to a certain pound rate," upon the basis or standard above mentioned, "of the full and fair annual value of the property, messuages, lands, tenements, and hereditaments, rateable to the relief of the poor."

COUPLING, in machinery, is, in a limited sense, the name given to various contrivances for effecting the longitudinal connection of shafts; though, in a more general sense, it may be extended to embrace the arrangements by which the parts of a machine may be connected or disconnected at pleasure, or by which a machine may be disengaged from, or re-engaged with, a revolving wheel or shaft, through which it receives motion from a steam-engine, water-wheel, or other prime mover.

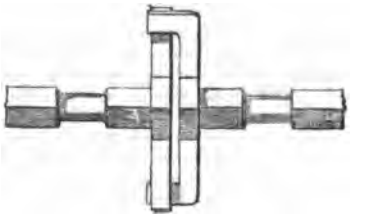
When it is required to communicate motion to a considerable distance from the source of power, as in the distribution of power to the various apartments of a cotton-mill, by gearing such as that represented under WHEELS, it is frequently necessary to construct the long shafts by which the motion is distributed in several pieces, not only owing to the impossibility of making them accurately of the required length, but also because, if they were so made, their expansion and contraction would occasion much inconvenience. It is further desirable, in many cases, to have the option of detaching one portion of a shaft from the moving power without stopping the adjacent portion.

In such cases, each distinct shaft, or portion of shaft, may be perfectly supported by bearings of its own, near each end; or, under certain circumstances, the coupling may be so constructed as to render one of the bearings unnecessary.

The simplest mode of connecting shafts which are supported by bearings near each end, is to make that portion of each shaft which projects beyond the bearings of a square shape, and to unite the adjacent ends by means of a *coupling-box*, which may be described as a square collar fitting the ends of the shafts, and capable of sliding along them in such a way that it will either embrace the ends of *both* shafts, in which case they must turn together like one piece, or that, when it is required to disconnect them, it may be slid fully on to *one* of the shafts, leaving the other entirely free. Holes are provided in both the coupling-box and the shaft, by which a pin may be inserted to hold the coupling-box in whichever position it may be required to retain. Sometimes, instead of the coupling-box being in the form of a sliding box or collar, it is formed in two halves, which may be separated at pleasure, and secured, when put together, by bolts or keys. On account of the greater facility of making them perfectly true, round couplings and coupling-boxes are occasionally used; but as their efficiency in transmitting power depends wholly upon the connecting pins, of which there should be two, passing completely through the shaft at right angles with each other, they are not so strong as square couplings.

Couplings are often effected without coupling-boxes, by the use of what are termed *clutches* or *glands*, in which projections of various forms from arms or discs attached to the ends of the shafts, are employed to lock them together, in some cases only while the machinery is in motion; while, by the removal of one of the engaging members, by sliding it back upon the shaft, the connection may be broken at pleasure. Such contrivances admit of infinite variety, and may be made to disengage themselves whenever the moving power ceases, by fixing one of the engaging members upon a pivot in such a manner that, when the pressure upon it is relaxed, it falls out of the way. This is especially the case with such clutches as act on the principle of the ratchet and click. *Fig.* 1 represents a clutch with projecting arms, which engage with each other by mere contact, and will turn in either direction. As the engaging members of this clutch are not attached to each other, it affords scope for expansion and contraction without occasioning the straining and injury which might be occasioned by a more rigid connection; and it also obviates the difficulty of throwing all the machinery into motion at the same moment, since one shaft may have to turn nearly half round before it has to impel the adjoining one. Sometimes, however, a similar coupling is so constructed that the connection is made by pins passing through the two arms. In some couplings the arms or glands are single, so that the connection may be compared to a common crank, instead of being double, and forming a double crank, as in *fig.* 1; and when it is desired to prevent the machinery from turning the wrong way, the arms may be jointed with a kind of hinge-joint, similar to that of a common two-foot rule, which will cause the bar to be quite stiff to resist a strain in one direction, although, if the motion be reversed, the joint will give way, and the connection will be broken.

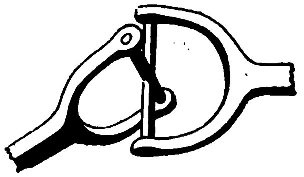
Fig. 1.



When each length of shaft has only one bearing, the coupling must be of such a construction as not merely to compel one shaft to turn with the other, but also to cause the supported end of one shaft to sustain, by a scarfed or mortice and tenon joint, or by some similar contrivance, the unsupported end of the adjoining shaft.

Fig. 2 represents one of various forms of the ingenious contrivance known as Hooke's universal joint, an apparatus by which shafts which do not lie in a straight line with each other, or which are liable to change their relative positions in this respect, may be made to turn each other. While it may be used as a substitute either for an ordinary coupling or for bevil gear, this joint or connection will accomplish what neither of those contrivances can do. As an illustration of the circumstances under which such a coupling may be employed, we may allude to a scheme patented in 1825, by Mr. James, for propelling railway carriages on steep inclinations by communicating the rotatory motion generated in a locomotive engine to all the wheels of every carriage in the train, through the medium of a system of rods thus connected, and consequently capable of receiving and imparting motion, whether the train were in a straight line or on a curve so great as to cause the side of one carriage to form an angle of 30° with that of the adjoining one. The details of this specimen of ingenuity, which is here referred to simply as affording a striking illustration of the powers of the universal joint as a coupling, are given in Hebert's 'Engineer's and Mechanic's Encyclopedia," vol. ii., pp. 465, 466.

Fig. 2.



When power is conveyed to a considerable distance by means of a series of revolving shafts, the motion often becomes irregular and uncertain; but this evil may be in a great measure rectified by placing a fly-wheel to equalise the motion at or near the extremity of the series.

In all contrivances for disengaging and re-engaging machinery while in motion, it is necessary to consider the effect of inertia, which renders it both difficult and hazardous to bring a machine suddenly from a state of rest to one of rapid motion. When the connection is formed by toothed or cogged wheels this difficulty is especially felt, and, consequently, while it is very easy to disconnect such wheels, or, as it is commonly termed, to throw them out of *gear*, either by removing the axis of one of the wheels, or by sliding one wheel along its axis until its teeth are disengaged from the other, they cannot be re-engaged without great risk of breaking the teeth. In this respect, as shown under Wheels, a connection by means of straps or cords is far preferable. Such a connection always has some degree of elasticity and power of yielding under the effect of sudden strains, and when employed in connection with the fast and loose pulley (a contrivance illustrated under Saw-mill), it affords perhaps the safest method known of starting and stopping machinery. Sometimes a similar effect is produced by the use of an endless cord or band passing round two pulleys, one of which is on a moveable axle, by the shifting of which the tension of the band may be destroyed. Where neither the axle of the driving pulley, nor that of the driven one, can be made moveable, the same effect may be produced by the use of a third pulley, or drum, so mounted that by pressing it against the band the tension may be increased to any desired amount, or by removing it out of the way, it may be destroyed. The small wheels (*e, e*) in the cut of part of Brunel's block machinery, given under Saw-mill, though merely employed for increasing the tension, and not for taking it off to stop the revolving saw, will illustrate such a contrivance. Bands are sometimes applied to a sliding pulley, which may be locked to the machinery at pleasure by engaging it with revolving glands, or with a bayonet coupling; but in such a case the shock of starting is not avoided, though the elasticity of the band, and its power of slipping on the pulley under the effect of sudden resistance, render it less hazardous than with cog-wheels.

Clutches or bayonet connections are sometimes employed to start a train of wheelwork in which the teeth themselves are never actually thrown out of gear. The disadvantages of such a mode of coupling may be in a great measure avoided by the use of a *friction clutch*, in which the driving-arms or projections are attached to an elastic open hoop or band of metal, sprung on to a smooth wheel or drum, and fitted with tightening screws, by which it may be pressed to any degree of tightness; so that while it will slip round until the inertia of the machinery is overcome in starting, or under the effect of accidental resistance, its friction will be sufficient, under ordinary circumstances, to cause it and the drum to turn together, as if they were one piece.

In another contrivance of the same character the connection is effected by pushing a solid conical wheel or drum, mounted upon one shaft, into a hollow cone attached to an adjoining shaft, in doing which the friction, and consequent power of transmitting motion, increases in proportion to the advance of the solid into the hollow cone. Friction wheels, with their peripheries formed of the end of the grain of wood, which may be compared to a collection of indefinitely small teeth, pressed together by levers, or friction wheels or discs placed side by side so as to be either a little separated or pressed together at pleasure, are also occasionally used. A coupling which starts the machinery gradually by friction may be connected with a fixed clutch or bayonet coupling in such a way that, when once started, the connection of the machinery shall be rigid, and no longer dependent upon mere friction.

Very full details upon the subject of this article are given in the excellent 'Practical Essays on Mill-Work and other Machinery,' by Robertson Buchanan, with additions by Tredgold and George Rennie, 8vo, Lond., 1841, pp. 262–306, where allusion is made to couplings which disengage themselves under the influence of any undue strain upon the machinery, and a plan is proposed for diminishing the risk of engaging cogged wheels, by introducing spring spokes in the larger wheel of the pair, the teeth of which are more likely to break than those of the pinion. The subject is also treated at some length in Barlow's 'Treatise on Manufactures and Machinery,' in the 'Encyclopædia Metropolitana,' sect. 46–51.

COURAN'TE, or CORANTO, a quick dance in triple time. In Handel's, Mattheson's, and other lessons for the harpsichord, composed towards the end of the 17th and beginning of the 18th centuries, a *Courante* is generally introduced as one of the movements.

COURIER, from the French *courir*, to run; a messenger sent in haste, or express; a bearer of despatches. The advantage of receiving the earliest intelligence, and of conveying orders with celerity, must have given rise to the employment of couriers at a very early period. Herodotus (viii. 98) gives a particular description of the speed of the Persian royal messengers who proceeded by relays. He says this mode of conveying intelligence was called by the Persians *ἀγγαρήϊον* (Angareïon); and the couriers themselves *ἄγγαροι* (angaroi). Another description of couriers among the Greeks were called *ἡμεροδρόμοι*, who appear to have been armed with a light spear or dart, &c. (Suidas *in voce.*) Herodotus (vi. 105) says that a little before the battle of Marathon, Pheidippides (an *ἡμεροδρόμος*, a runner by profession) being sent by the Athenian generals, arrived at Sparta on the second day after leaving Athens, a distance not less than 140 or 150 miles. (See also Suidas, *v.* *Ἱππίας*.) The mode of employing couriers by Cyrus, as described by Xenophon ('Cyropædia,' viii., 6), appears to be nothing more than the system already referred to as described by Herodotus. He ascertained the journey which a horse could fairly perform within a day, and placed stables at regular distances, so that messengers could receive or deliver letters from hand to hand.—Gibbon, in his 'Decline and Fall of the Roman Empire' (chap. ii.), speaks of the swiftness and regularity of the Roman posts. The Romans called such messengers *cursores*: they were sometimes sent on foot and sometimes on horseback. The earliest couriers of the European nations were probably what have since been called running-footmen. In manuscripts of the 13th century such messengers are occasionally styled *trottarii* or trotters. The running-footmen or couriers, who accompanied John Duke of Marlborough in his wars, are several times represented in the tapestries at Blenheim-house. The word has also been used in modern times for a travelling attendant on persons or families journeying in a foreign country.

COURSE OF EXCHANGE. [Exchange.]

COURT BARON. [Manor.]

COURT-MARTIAL, a tribunal occasionally instituted for the purpose of trying military and naval men for the commission of offences affecting discipline in either of those branches of the public service.

Courts for the trial of rebels by martial law appear to have early existed in this country; and in the time of Henry VIII., the Marshal of England held one regularly for the trial of causes connected with military discipline. In the reigns of Elizabeth and her successor, those courts of war, as they were called, were superintended not by the marshal, but by a president chosen for the purpose. This president was probably a general or field-officer, but captains of companies were allowed to sit as members. The colonel of each regiment was charged with the duty of preparing the evidence relating to offences which fell under his cognisance, and of bringing it before the court.

But courts-martial in their present form were instituted in the reign of James II. in the year 1686, when ordinances of war were issued for regulating the discipline of the army. Since the revolution of 1688, their existence and jurisdiction depend on the will of Parliament, expressed year by year in statutes known as the Mutiny Act, and the Marine Mutiny Act, which are expressly limited to the duration of one year. Naval courts-martial differ in this from courts-martial in the army or the marines, that the former derive their constitution and authority from a permanent statute, the 22 Geo. II., c. 33. The East India Company's European troops in India continued to be subject to the Mutiny Act and Articles of War, in force with regard to the troops of the United Kingdom, until the year 1754, when an Act was passed, and Articles of War, very similar to those in force for the royal army were promulgated expressly for that division of the Company's troops. A new code was afterwards framed in the year 1823, and alterations have been made in successive years up to the latest Act, passed in July, 1849, and the Articles of War, issued the same year. The Company's native troops continued to serve, subject to the discipline and rules of the British Mutiny Act and Articles of War, till separate codes were framed for the three presidencies in the end of the last century. These separate codes for the native troops were revised and consolidated in the year 1845, and again altered and framed anew, as a single code for all the native troops of the Company in 1847. By the Act for 'the better Government of India,' the 21 & 22 Vict., c. 106, transferring the powers and jurisdiction of the East India Company to the Crown, the military and naval forces of the East India Company are to be deemed to be the Indian military and naval forces of her Majesty, and are continued on the same footing, and subject to the same regulations, statutes, and articles of war in all respects as existed at the time of the passing of the Act.

Courts-martial may be of three kinds; general courts-martial, district or garrison courts-martial, and regimental courts-martial.

General courts-martial are assembled under the authority of the queen, or of an officer, having the chief command within any part of her Majesty's dominions, to whom such authority may be delegated by commission or warrant under the sign manual. Regimental courts-martial are held by the appointment of the commanding officer of the regiment. What are called detachment courts-martial, may be either general or regimental, and their appellation is derived from the nature of the command with which the officer convening the court is invested.

The chief crimes of which a general court-martial takes cognisance are mutiny, traitorous correspondence with the enemy, abandonment of a fortress, post, or guard committed to the charge of an officer or soldier, disobedience of orders, and desertion; these crimes, if proved to their greatest extent, are punishable with death; and the penalty extends to any military man, being present, who does not use his best endeavours to prevent them. The crime of desertion includes the fact of enlisting in any regiment without having had a regular discharge from that in which the offender may have last served. The practice of sending challenges between commissioned officers, is punished with cashiering; between non-commissioned officers and privates, with corporal punishment; and, in all cases, seconds and accessories are held to be equally guilty with the principals. Self-mutilation, theft, embezzlement of money or of stores, making false returns of stores, and neglect of ordinary duty, in non-commissioned officers and privates, are punishable with penal servitude, imprisonment with or without hard labour, and in addition thereto with the forfeiture of all additional pay or good conduct pay or claim to pension upon discharge, corporal punishment not exceeding fifty lashes, or discharge from the service with ignominy; and men of the former class may, in addition to other punishments, be suspended, or degraded to the ranks. There are many offences which might tend to the subversion of discipline, but which are hardly capable of being precisely defined, such as immoralities, and behaving in a manner unbecoming an officer and a gentleman; of these the courts-martial take cognisance, and on conviction the offender may be dismissed from the service. At home, military men are not, in general, amenable to courts-martial for civil offences; but abroad, where there may be no civil courts, the case is different.

The provisions of the Mutiny Act affect not only the cavalry and infantry of the regular army, but extend to the officers and privates in the corps of artillery, engineers, military surveyors and draughtsmen, or in the field or military train, or medical staff corps, or hospital corps; to all troops serving in India, or serving in the colonies; to the militia and yeomanry, during the time that they are assembled and being trained, if expressly so provided by the Act embodying them. Discipline in the marines is regulated by the Marine Mutiny Act. All are subject, without distinction, to trial and punishment by courts-martial.

The rules of the service require that the president of every general court-martial should be a field-officer, if one of that rank can be obtained; but he must not be inferior in rank to a captain, save in the case of a detachment general court-martial holden out of the crown's dominions, where a captain cannot be obtained. And it should be observed, that none of the members are to be subalterns when a field-officer is to be tried. The president of every court-martial is appointed by the authority convening the court, and it is required that such president shall in no case be the person whose duty it is afterwards to confirm the proceedings, or has been, previously, to investigate the charges on which the prisoner was to be arraigned. A judge-advocate is appointed to conduct the prosecution in the name of the sovereign, and act as the recorder of the court.

No general courts-martial held in Great Britain or Ireland, the Ionian Islands, or British India, are to consist of less than thirteen commissioned officers; in St. Helena, British settlements on the western coast of Africa, Honduras, New Zealand, the Australian colonies, British settlements on the coast of China, Prince of Wales' Island, Singapore and Malacca, of less than five; in Jamaica, the Windward and Leeward Islands, British Guiana, Newfoundland, Bermuda, the Bahamas, the Cape of Good Hope or other settlements in southern Africa, or any place out of the British dominions excepting the places already mentioned, of less than seven commissioned officers. Commonly, however, a greater number are appointed, in order to guard against accidents arising from any of the members being found disqualified, or falling sick. An uneven number is purposely appointed, in order that there may be always a casting vote; and the concurrence of two-thirds of the members composing the court is requisite in every capital sentence. No officer serving in the militia can sit in any court-martial upon the trial of an officer or soldier in the regular army; and no officer in the regulars is allowed to sit in a court-martial on the trial of an officer or private serving in the militia. The members of the court take rank according to the date of their commissions; they are always sworn to do their duty; and the evidence on the trial is taken upon oath.

In the accusation the crime or offence must be clearly expressed, and the acts of guilt directly charged against the accused; the time and place must be set forth with all possible accuracy; and, at a general court-martial, a copy of the charge must be furnished by the judge-advocate to the accused, that he may have full opportunity of preparing his defence. The accused has the power of challenging any of the members, but the reason of the challenge must be given, and this must be well-founded, otherwise it would not be admitted; for the ends of justice might be often defeated from the impossibility of getting members to replace those who were challenged.

The court must discuss every charge brought against the accused, throwing out only such as are irrelevant; and judgment must be given either upon each article separately, or the decision of the court upon all may be included in one verdict. The evidence is taken down in writing, which affords to every member of the court the opportunity of comparing the proceedings with his own private notes, and of thus making himself completely master of the whole case before he is required to give his opinion. At the last stage of the trial, the decisions of the several members are taken in succession, beginning with the junior officer on the list; a regulation obviously adopted in order to secure the unbiassed opinions of those who might otherwise be influenced by deference to the members who are superior to them in age or rank.

District or garrison courts martial must consist of not less than seven commissioned officers, except in Bermuda, the Bahamas, Cape of Good Hope, or other settlements in Southern Africa, St. Helena, Jamaica, Honduras, Newfoundland, New Zealand, the Australian Colonies, the Windward and Leeward Islands, British Guiana, Hong Kong, and the settlements on the Coast of China, where it may consist of not less than five; and in the settlements on the western coast of Africa, where it may consist of not less than three commissioned officers. The president must be a field officer if such officer can be had, and if not, then an officer not under the rank of captain; and the power of the court is the same as that of a general court-martial, save only that it cannot try a commissioned officer, or pass any sentence of death or penal servitude.

Regimental or detachment courts-martial are appointed by the commanding officer, for the purpose of inquiring into criminal matters of the inferior degrees; and they are empowered to inflict corporal punishments or imprisonment, and forfeiture of pay for a limited time. The Mutiny Act and Articles of War require that not less than five officers should constitute a court of this nature, or three when five cannot be obtained. The president must not in any case be under the rank of a captain, save in the case of a court holden on the line of march, or on board a transport-ship, convict-ship, merchant-vessel, or troop-ship, not in commission, or on any foreign station where a captain cannot be had. The practice is to appoint a captain as president, and four or two subalterns as the case may be; the court has no judge-advocate to direct it; and the members therefore must act on their own responsibility. The proceedings are to be taken down in writing, and the sentence cannot be put in execution till it has been confirmed by the commanding officer, or by the governor of the garrison.

An inferior officer, or private soldier, who thinks himself wronged by a commissioned officer, may, on application to the commanding officer of the regiment, have his cause brought before a regimental court-martial, although no commissioned officer is amenable to that tribunal, and, if the complaint is judged to be well founded, he may on that authority require a general court-martial to be held.

An appeal by the party who conceives that he has suffered injustice, lies from a regimental to a general court-martial. But upon a matter which clearly lies within the jurisdiction of the courts military, there is no appeal to the courts of law or equity. Yet as courts-martial are bound to act within their proper jurisdiction and in accordance with the ordinary rules of evidence, irregularities, of a character which amount to a denial of justice, will afford a sufficient ground for the Supreme Courts of Law to interfere, either by a prohibition to stay the proceedings, or to set aside the sentence, and discharge the prisoner, or to grant a writ of *habeas corpus* to bring up the prisoner with a view to staying execution of the sentence, and affording time for further inquiry.

After the sentence of the court-martial has been ascertained, it is transmitted to the sovereign, who may either confirm it, or, if sufficient reason should exist, may, on the ground that the process is not complete till the sentence has received the royal sanction, return it to the court for revision; or without having recourse to any such step, it is within the royal prerogative to remit the punishment awarded.

The chief distinction between the trial by court-martial and by jury is, that in the latter the verdict must be unanimous, while in the former the concurrence of a majority only determines the verdict; but if it should happen in courts-martial composed through necessity of an even number, that the court is equally divided, this is received as a verdict of acquittal. Judgment of death, however, cannot be given but with the concurrence of two-thirds of the court. No officer or private soldier, or other person subject to the laws of war, who has been acquitted by the civil magistrate, or by the verdict of a jury, is liable to be tried again by a court-martial on the same charge; the crown, however, has still the power, notwithstanding such acquittal, to dismiss the officer from the service, and thereby save the profession from the society of a guilty man, who has escaped through a failure of justice only; but such prerogative of the crown is properly limited to the power of cashiering.

Naval courts-martial had no legal existence before the year 1661, and even custom till then had only sanctioned a reference of causes of complaint in the fleet to the decision of two or three senior officers in accordance with "the usages of war;" but by the 13 Car. II. c. 9, tribunals of this nature were established, and their jurisdiction ascertained, the crimes triable before them being determined, and the punishments which they might inflict. That statute was repealed by the 22 Geo. II. c. 33, and the law relating to them is now to be found in this Act, and in the 19 Geo. III. c. 17; the 10 & 11 Vict. c. 59; and the 10 & 11 Vict. c. 62; the Articles of War; and the queen's regulations together with the instructions issued to the fleet by the Board of Admiralty in 1844. The person empowered to assemble a court-martial in the navy is the officer in chief command of the fleet or squadron, who has received authority for that purpose by warrant from the Board of Admiralty; or the senior officer, commanding a detachment of the fleet or squadron on separate service, who has received such authority under the hand of the officer in chief command that sent him in command on separate service. A court-martial must consist of not more than thirteen, and not less than five officers, and these officers must be the senior flag officers and captains, *then and there present*; but in case there should be a scarcity of flag officers and captains on the station, the court may consist of three post-captains and the two senior commanders. A court which includes more than two commanders is not legally constituted. An officer who is not on full pay and in commission in his proper rank, may not serve as a member of the court; nor may an officer, whose rank entitling him to be a member, has only been conferred on him by the officer commanding in chief, and not yet been notified to him by the Admiralty. Every officer, in order to be capable of serving, is required to be *then and there present*, which is held to mean that the captain's or commander's ship must be on the station, and that an admiral, if he come from another station for the purpose of serving, must hoist his flag on a ship in commission at the station in question. If a sufficient number of ships should meet at any foreign station, the statute authorises the officer who shall be senior in command to assemble a court martial, but it is held that he cannot do so without the special warrant of the Admiralty sent to him for that purpose. The court must be held afloat; it cannot assemble on shore without a special Act of Parliament to give it the right. There is no power of challenge, as of right, either to the Judge Advocate or to the prisoner; but as a matter of courtesy, challenges are allowed in practice for good and sufficient reason given. When the court has been completely constituted, the members are sworn to do their duty, and so also is the Judge Advocate; the evidence is taken upon oath; and the court sits from day to day, except Sundays, until the sentence is given. Were it to adjourn even over one day only, the proceedings would thereby be rendered illegal. The jurisdiction of the court extends not only to the usual offences known to the criminal law of this country, but to offences against the discipline and duty observed by the service. Charges against a prisoner cannot be proceeded with unless they have been made in writing to the Lords of the Admiralty, or to the officer commanding in chief, within three years from the time of committing the offence, or within one year after the return of the fleet, squadron, or ship, in which the offender is serving, or of the offender himself to Great Britain or Ireland. And the prisoner is entitled to have a copy of the charges against him twenty-four hours before the trial, unless there be extraordinary circumstances to excuse it, as in the case of sudden mutiny; but he is not entitled to any copy of the evidence by which the charges are to be sustained.

(Grose, *Military Antiquities*; Tytler, *Essay on Military Law*; Prendergast, *Law relating to Officers in the Army*; Byerly Thompson, *Military Forces and Institutions of Great Britain*; Hickman, *Naval Courts-Martial*; Hough, *Courts-Martial*.)

COURT OF RECORD. [COURTS.]

COURT ROLLS. [COPYHOLD.]

COURTESY OF ENGLAND is the title of a husband to enjoy for life, after his wife's decease, the real property of the wife. It is said to be called the "courtesy of England" as being a law peculiar to this country. In the law of Scotland, however, it is known by a similar title, as the courtesy or "jus curialitatis." It is spoken of in a Rescript of Constantine, Cod. vi., 59, 1; and in the laws of the Alemanni (Lindenbrog, 'Codex Legum Antiquarum,' 1613, p. 387; 'Lex Aleman.,' c. 92); though by the law of the Alemanni the husband took the inheritance under circumstances similar to those that establish the title to a life estate only in the English law. This title of the husband's tenancy of the estates of his wife depends upon a valid marriage, the seisin of the wife during marriage of the same estate respecting which the courtesy is claimed, issue born alive during the wife's life capable of inheriting, and the death of the wife. Lands held by the wife descendible only to her sons would not, in case of the birth of a daughter, be subject to this title of the husband; nor would a child brought into the world by the cæsarean operation, after the mother's death, establish it. It differs from the similar rights of the wife to dower in several respects, the wife taking only part of the husband's estate, and being entitled to her tenancy though no issue is born; whereas the husband takes the whole estate, the caput baroniæ, and such indivisible rights out of which dower is not or cannot be assigned. By the custom of Gavelkind, a man may be tenant by the courtesy without having had issue by his wife.

COURTESY OF SCOTLAND, otherwise called in the law of that kingdom "jus curialitatis," or right of courtship, is substantially the same with the courtesy of England. As in the latter kingdom, five things are necessary to it; namely, marriage, that the wife is an heiress and infeft, issue, and the death of the wife.

According to the ancient law, the courtesy extended only to such lands as the woman brought in tocher; but afterwards it became extended to all the lands to which she had right by inheritance. It was always the law that the wife must be seised. The fourth requisite is, inheritable issue born alive of the marriage; that is to say, the child born must be the heir of the mother's estate, and it must have been heard to cry; for though it be otherwise in England, crying is in Scotland the only legal evidence of life. In the last place, by such issue the husband has during the life of the wife only *jus mariti*, as Skene says ('De verb. signif. voce Curialitas'); after her decease he has *jus curialitatis*; or, as Blackstone speaks, with reference to the law of England, the husband by the birth of the child becomes tenant by the courtesy *initiate*, but his estate is not *consummated* till the wife's death, which is the fifth and last requisite to give the complete right of courtesy, the husband needing no seisin or other solemnity to perfect his title.

COURTS. The courts of common law in this country, like most other branches of our constitution, have grown up gradually with the progress of the nation, and may be traced back, partly to the institutions of our Anglo-Saxon forefathers, and partly to the more artificial systems introduced under the government of the Normans. From the earliest times of which we have any account, we find the tribunals of the Germanic nations consisting of a presiding officer, called Graf Reeve or Earl, Comes or Count; together with certain assessors, whose denominations (and probably their functions also) were different among different tribes and at different periods. Of this nature were the earliest tribunals with which we are acquainted in this country. The most important of these was that whose jurisdiction extended over a shire or county, in which the presiding officer was at first the alderman, earl, or count, and subsequently his deputy the vice-count or sheriff (shire reeve). This tribunal exercised ecclesiastical as well as civil jurisdiction, and the bishop sat as an associate to the earl or sheriff.

The judicial functions of this court were divided into four distinct branches. The first included all ecclesiastical matters; and in these the bishop was judge, and the sheriff the assistant, who, if necessary, enforced the sentence of the court by imprisonment. The second branch (in which the sheriff was judge) included all temporal offences, such as felony, assaults, nuisances, and the like. The third head included all actions of a purely civil nature: here the sheriff was the presiding officer, and executed the judgment; but the judges were the freeholders who did suit to the court. And fourthly, the sheriff's court held an inquest yearly of frank pledge. The first branch of the jurisdiction of this tribunal was transferred to the Church by the Conqueror, and the bishop soon ceased to sit with the civil magistrate. The criminal jurisdiction of the sheriff has long been obsolete; his civil jurisdiction has been transferred to the new County Courts [COUNTY COURTS]; and the view of frank pledge now exists only as a form.

In order to exercise his criminal jurisdiction, the sheriff was required twice in every year to make a tour or circuit of his county. The power of determining felonies was taken away by Magna Charta, but the remains of this tribunal are still known as the sheriff's tourn, and in it cognisance may be taken of false weights, nuisance, and other misdemeanors. The view of frank pledge ought to be taken at this tourn.

The land over which the jurisdiction of the sheriff extended is said to have been distinguished as reeve land. The thanes or nobles had, in the lands granted to them, a similar jurisdiction of their own, as well civil as criminal. (1, Reeve's 'Hist. of English Law,' 7.) The limits between the jurisdiction of the sheriff and that of the lord were strictly preserved. But when the lord had no court, or refused to do justice, or when the parties were not both subject to his jurisdiction, the suit was referred to the tribunal of the Reeve; and a suit commenced before the lord might be removed by the defendant before the higher tribunal.

The civil tribunal of the lord was similar to the county court in its constitution and its powers, except that the presiding officer was not a public functionary (as the reeve was), but the bailiff of the lord. This tribunal still exists under the style of the court-baron, and is incident to every manor in the kindom. The judges are the freeholders who owe suit and service to the lord of the manor, and if there are not at least two such freeholders in the manor the court is lost. This was formerly the proper court in which to commence real actions to try the title to lands within the manor. The lord's tribunal in criminal cases, in which he had the same powers that the sheriff exercised in his tourn, was called the Leet.

The same powers which were exercised over a particular manor by the court baron and court leet were also exercised over particular hundreds by the hundred court and the leet of the hundred. But the number of these courts was much diminished by stat. 14 Edward III., by which all hundreds, except such as were of estate in fee, were rejoined (as to the bailiwick of the same) to the counties at large.

Besides these courts of inferior jurisdiction, there was also a supreme tribunal, in which the king presided. In the Saxon age, and for some time after, the legislative, the administrative, and the judicial functions of the government had not been separated; and the Wittena-gemote, or meeting of the wise, was consulted by the monarch in all these departments indiscriminately. The Anglo-Saxon king had the same jurisdiction over his thanes that they had over their own vassals. He punished all enormous crimes committed against the king's peace. His court was likewise open to all those to whom justice had been refused in the inferior tribunals; and he had the power of punishing the judges if they pronounced an iniquitous sentence. It also seems probable that the king's court was a court of appeal, in which the judgments of all other tribunals, if erroneous, might be reversed.

The Norman Conquest does not seem to have produced any immediate change in the constitution of this national assembly, which thenceforth became more known as the Great Council. Its members exercised the same varied functions as under the Saxons; but when they sat in their judicial capacity, they had the assistance of the great officers of state and certain persons learned in the law, styled Justiciars, or Justices. William the Conqueror also created an officer to preside over judicial business, under the title of Chief Justiciar. The functions of this tribunal thus became gradually separated from the general business of the grand council; and from being held in the hall of the king's palace it was distinguished by the style of Aula Regis. A great distinction was drawn between this and all the courts of Saxon origin, from the mode of authenticating its proceedings. There were at this time no written memorials of legal proceedings, and indeed of few other public acts; and when it was necessary to establish any judgment or statute which had been made by the king assisted by his council, it was usual to call the testimony of some of the nobles who were present to bear *record* of the fact. In progress of time, all such proceedings were written down at the time on parchment, the nobles present signing their names as witnesses, and so bearing record of the truth of what was there alleged. The writing itself was called a record; and it was held to be evidence so conclusive that, when produced, nothing was allowed to be alleged in derogation of it. The entry of proceedings on record was adopted in the judicial, as well as in the other departments of the great council, and hence the Aula Regis became distinguished as *a court of record.* The power and importance of the Aula Regis rapidly increased. It not only maintained the former powers of the council in punishing offences against the public, in controlling the proceedings of inferior courts, and in deciding on questions relating to the revenue of the king, but it engrossed also a great portion of the "common pleas," or causes between party and party. And though we may suppose that it was only the more important causes that were taken into the Aula Regis, yet as early as the reign of Edward I., when the jurisdiction of the county courts was confined to 40*s*., all actions above that amount were brought into the king's courts.

The Aula Regis seems at a very early period to have been distinguished as exercising three several capacities, according to the different natures of the causes that were brought before it, which are treated of in our earlier legal writers as pleas of the king, common pleas, and pleas of the exchequer. The bond of connection between these several jurisdictions was the chief justiciar, who presided over all of them. But in the reign of Edward III. this office was abolished, and thus were finally destroyed the unity of the Aula Regis and its connection with the grand council, which became henceforth essentially a legislative body; and though it still retains traces of its original functions in its title of the *High Court* of Parliament, yet it has ever since ceased to exercise any judicial powers, except in cases of impeachment, or as a court of ultimate appeal. On the dissolution of the Aula Regis, the three courts of the King's Bench, the Common Pleas, and the Exchequer, had each of them a perfectly distinct and separate existence. The Court of King's Bench had the control of all the inferior tribunals and the cognisance of all trespasses against the king's peace; the Court of Exchequer had cognisance of all cases relating to the revenue; and the Court of Common Pleas was the only tribunal for causes of a purely civil nature between private persons. The courts of King's Bench and Exchequer still retain each of them its peculiar jurisdiction; and the Common Pleas is still the only court in Westminster in which a real action can be tried; but the great mass of causes between party and party may now be brought indiscriminately in any of the three courts. The mode in which the King's Bench and the Exchequer originally contrived by fictitious proceedings to appropriate to themselves a share in the peculiar jurisdiction of the Common Pleas will be found in the accounts given of those courts.

The Saxon kings had been in the habit of making progresses through their dominions for the purpose of administering justice. This practice was not continued by William the Conqueror; but he annually summoned his great council to sit at the three feasts of Easter, Whitsuntide, and Christmas, in three different parts of the kingdom: Winchester, Westminster, and Gloucester. But when the great mass of the legal business of the country was brought into the king's courts at Westminster it became necessary to take some more efficient measures for the trial of causes in the country.

The first expedient adopted was to appoint itinerant judges, Justices in Eyre, who travelled through the kingdom, holding plea of all causes civil or criminal, and in most respects discharging the office of the superior courts. These itinera or eyres usually took place after an interval of seven years. From them we have our modern assizes; the immediate origin of which was a statute of Edward I., which in order to prevent the expense of bringing up juries to the courts at Westminster, provided that certain judges of those courts should be appointed to make circuits twice a year for the trial of issues, upon which judgment was to be given in the court above. These justices are appointed by commissions of Oyer and Terminer and of gaol delivery, which authorise them to try criminals. They have also a commission of the peace, and a commission of assize, under which they used to try a peculiar species of action called assizes. These actions have long been obsolete; but the name of assizes is still given to the sittings of the justices on circuit under their several commissions.

Under the Norman kings the fines, amerciaments, and forfeitures in the courts constituted a considerable portion of the revenue, and the administration of justice was held to be an important branch of the royal prerogative. But, like other branches of the prerogative, we sometimes find it in the hands of a subject, either by grant from the crown, or by prescription, which, in the eye of the law, supposes a grant, though such supposition is often at variance with probability; within the counties palatine and other royal franchises, the earls or lords had regal jurisdiction, saving the supreme dominion of the crown. They had the same right as the king to pardon offences; they appointed judges of eyre, assize, and gaol delivery, and justices of the peace; all legal proceedings were made in their name, and offences were said to be committed against their peace, as in other places against the peace of the king. These royal prerogatives were, for the most part, reannexed to the crown by stat. 27 Henry VIII.; but the form of the judicial establishment still remained. The County Palatine of Pembroke was abolished by the same statute, and the County Palatine of Hallamshire shared the same fate in the reign of Elizabeth. The Counties Palatine of Chester and Lancaster are still in existence, but have long ceased to be in the hands of subjects. The palatinate jurisdiction of Durham continued to our own day to be possessed by the bishop, but this also has been vested in the crown. By another statute the secular jurisdiction of the bishop of Ely has been abolished.

But besides these palatinate jurisdictions, created to increase the power and gratify the pride of the nobles on whom they were conferred, the crown has also from time to time erected courts, with a jurisdiction limited in point of territory, and always under the control of the superior courts. In the Saxon times the boroughs had courts similar to those of the hundreds; and as commerce increased, it was found of the utmost importance to them to be relieved from the jurisdiction of the feudal lord, and at the same time to have some court of justice to apply to, less distant, dilatory, and expensive, than the courts at Westminster. Accordingly there has, at some time or other, been granted to almost every borough of any importance, the power of exercising civil and criminal jurisdiction within certain prescribed limits. These courts were in all cases courts of record, but in other respects were not modelled on any uniform system. There was the greatest possible variety in their constitution and the extent of their powers. But the mode of proceeding in all of them was founded on the common law and the practice of the superior courts, and a writ of error lay into the King's Bench, except from the courts of London and the Cinque Ports. By far the greater number of these courts have fallen into disuse, but many of them still exist in great efficiency, particularly in London, Bristol, Manchester, Liverpool, and other cities and towns.

The courts at Westminster, when a cause commenced there has been carried through all its preliminary stages, may send it by writ of trial, to be tried before a judge of one of these borough courts, the judgment, after trial, being given in the superior court.

The administration of justice, which, under the Saxons, was essentially local, rising from the smaller jurisdiction gradually to the higher, became, under the Norman dynasty, centered in one point, the monarch being the fountain of justice. This system of centralisation, connected as it was with the principles of feudalism, which so long prevailed in this island with peculiar force, was elaborated, in the course of centuries, to a high state of perfection; it absorbed the remains of the ancient local jurisdictions, and stunted all attempts at the establishment of new. But as the artificial systems and feudal associations, for which we are indebted to the Normans, gradually wore away, the public mind became prepared to revert to the simpler and more poular institutions which existed ages ago among our forefathers, and which seem to be peculiarly adapted to the character of the Germanic nations. This led to the establishment, in all populous places, of courts of requests and courts of conscience, which to some extent supplied the place of the ancient local courts, and finally to the creation in 1846 of the new county courts [COUNTY COURTS], by which the administration of civil justice has once more been brought to every man's door.

The great mass of the litigation of the kingdom is carried on by means of the superior courts of Westminster; which term includes the court of chancery. The origin of the jurisdiction exercised in that court is explained elsewhere. [CHANCELLOR; CHANCERY.] A similar observation applies to what are usually called the superior courts of common law [COMMON PLEAS; EXCHEQUER; QUEEN'S BENCH]; although that term strictly includes the palatine courts.

In each of the supreme courts of common law there is a chief and several puisne judges. In the exchequer these are styled the chief baron and barons, no doubt bearing in their title traces of the time when their office was filled by the lords of parliament. Another remnant of the original constitution of the courts appears in the appellation of "my lord," which is always given to the judges in their official character.

During the terms, which are four periods in the year of about three weeks each, the three courts sit at Westminster for the determination of all questions of law; and twice a year fourteen of the judges make their circuits through England and Wales, to try, with the assistance of juries, all disputed questions of fact that arise in the country. Actions brought in Middlesex or London are tried in the same manner at the sittings which are held on certain days in and immediately after every term.

From each of the three courts there lies an appeal to the Court of Exchequer Chamber, whence a further appeal lies to the House of Lords.

(Reeve, *History of the English Law*; Maddox, *History of the Exchequer*; Palgrave, *Progress of the English Commonwealth*; Allen, *Inquiry into the Prerogative*.)

COURTS, ECCLESIASTICAL. [ECCLESIASTICAL COURTS.]

COVE, is a small inlet on a rocky coast. When the indentation is wide and deep enough to admit vessels of fifty tons burden and upwards, it is called a harbour; but when it is too narrow for that purpose, and can only be entered by small craft, it is called a cove.

COVENANT is a written agreement, by deed under seal, between two or more persons, whereby some act is agreed to be done; or, upon the happening of some event, some charge or liability is agreed to be borne by some party thereto. The person entering into the agreement and subjecting himself to the penalty of its breach, is called the covenantor, and the person with whom it is made, the covenantee. The portion of the agreement which expresses the character of the liability of the covenantor is called the lien.

Covenants take many varieties of forms, and are variously stated. They usually arise from the express words of the parties, but any words denoting the intention are sufficient: as, "I agree," "I am content." They are sometimes inferred, by law, from the relation of the parties or from the nature of their contract. Thus a demise for a term of years, will sustain, upon an implied covenant, an action for quiet enjoyment.

The lien of covenants usually contains introductory words, declaring the extent of the covenant. If there are several covenantors, it usually declares the covenant to be several, or joint, or joint and several. In case the covenant is several, each of the covenantors covenants for himself alone, and may be sued alone; if joint, each of the covenantors covenants for himself as well as for each other, and all must be sued together; if joint and several, each party covenants for himself, and as a surety for those with him, and an action, in this case, may be brought against one of the covenantors only, or, against all. The courts, however, even in these cases, regard the interests of the parties; and if the interest, or cause of action, is joint, the action must be brought against all the covenantors, though the terms of their covenant may be joint and several; and if the interest, or cause of action, is several, though the covenant is joint, the parties must be severally sued. The reason is, that difficulty would arise if judgment in distinct actions should be asked for one and the same cause against several persons, or against persons whom there is no cause of action to affect. The mere terms of a covenant are not therefore a sufficient guide to determine the propriety of joining parties in an action upon it.

Covenants are divided into real and personal, though, as now used, they are as to remedy, chiefly personal.

The former affect realty, and may bind the real estate of the covenantor in the hands of the heir and of his assigns. Personal covenants bind only the covenantor, or his executors and administrators, that is, his personal estate in their hands. The objects of real covenants are generally to afford some specific advantage or protection to those into whose hands the realty to which they relate shall pass; or, to secure the performance of some specific duty by those who may possess the realty to which they relate.

In the construction of all covenants the intention of the parties is regarded. The general rules usually laid down for this purpose depend upon the presumed intention of the parties; and for this reason, a statute declaring the effect of certain covenants, and enabling them to be stated in a few words, has often been desired, in order to shorten the length of conveyance and to avoid litigation. By such a measure the express intention of the parties would always appear in deeds, by their adoption of the abbreviated language of the law, or by their restraining its general effect. Indeed, in the statutes relating to the registry of deeds in Yorkshire, it is declared that the words "grant, bargain, and sell," are to operate as covenants for title, for farther assurance, and for quiet enjoyment, while on the other hand the stat. 8 & 9 Vict. c. 106, enacts, that in deeds executed after Oct. 1, 1845, the word "give" or the word "grant" shall *not* imply any covenant in law in respect of any tenements or hereditaments except so far as the word "give" or the word "grant" may, by force of any act of parliament, imply a covenant.

The intention of the parties, however, is not always sufficient, in the case of real covenants, to secure their object. It is frequently desirable, when the possession of land is parted with, that the purchaser and his assignees should always be able to resort to the vendor or to his heirs for protection, or that the purchaser and his assignees should perform certain duties, and that the covenants for these purposes should always be connected with the party enjoying the land, or, in other words, that such covenants shall "run with the land." In order that this shall occur, the mere intention of the parties, however definitely expressed, is insufficient; there must also be privity of estate. When land mortgaged in fee was demised by the mortgagor, a covenant entered into with him was merely personal; for though in equity the owner of the estate, at law the mortgagor is a mere stranger to it: there was no privity of estate between the lessor and lessee. (Webb *v.* Russell, 3 Term Rep., 402, 678; 1 Hen. Blackstone, 562.) The assignee also must come in of the same estate as his assignor, or the covenant will also be merely personal. Thus, a covenant to pay a fee farm rent, in a deed enabling the purchaser to appoint his estate to uses, became a mere personal covenant by the exercise of the power to appoint, for the appointment did not convey the same estate that the purchaser had acquired. (Roach *v.* Wadham, 6 East. 289.) [USES.] The Real Property Commissioners have stated three rules respecting covenants running with the land.

1. A covenant to run with the land so as to bind the assignee, or to give to him the benefit of it without his being named, must relate directly to the land, or to a thing parcel of the demise; such is a covenant to pay rent, to keep buildings in repair, or to observe particular modes of cultivation. 2. When it respects a thing not in existence, but which, when it comes into existence, will be annexed to the land, the covenant will bind the assigns by naming them, but will not bind them unless named; such is a covenant to erect buildings, or to plant trees. 3. When it respects a thing not annexed, nor to be annexed, to the land, or a thing merely collateral, or in its nature merely personal, the covenant will not run, that is, it will not bind the assignee, nor pass to him, even though named; such as a covenant to haul coals to the lessor's house, to grind corn at his mill, or to buy or sell stock in a certain manner. These rules, however, though originally laid down with reference to leases, have been treated as applying to cases not involving the relation of landlord and tenant. They involve many subtle distinctions, and it has been proposed that all covenants, of whatever nature or for whatever purpose, should, unless a contrary intention is expressed, or may be inferred from the instrument, bind the assignee of terms.

The Law Commissioners also divide covenants where the relation of landlord and tenant, or lessee and reversioner, does not exist, into three classes. 1. Covenants made *with* the owner of the land to which they relate; as covenants for title, to indemnify from existing charges, for farther assurance, &c., which supply the old remedy of warranty, with the difference, that pecuniary damages, instead of the recompense of land, are obtained under them. 2. Covenants made by the owner of the land to which they relate; as to build on certain land, to keep up a road, to keep a space of ground open. 3. Covenants relating to the production of writings and title-deeds; as in cases where an estate is divided into fractions and sold to different persons, one of the purchasers, usually the purchaser of the most valuable share, holding the deeds and writings. It has been contended that a covenant by the owner of land respecting the land should always run with the land; but this doctrine has not been established, and if sanctioned, might give an injurious control over property for an indefinite period. A covenant entered into by a purchaser of land for himself, his heirs, and assigns, not to use the land purchased for certain purposes, as for instance to abstain from building on it, has been held *in equity* to bind all succeeding purchasers who have notice of the covenant. (*Tulk* v. *Moxhay*, 11 Beav. 571.)

At common law, none but parties or privies, by contract or estate, could take advantage of covenants, or be bound by them. Upon the dissolution of monasteries, great evils were found to follow from this state of the law, the lands then seized by the crown, and afterwards transferred to patentees or grantees of the crown, being leased under covenants, which ceased to be binding by the absence of any privity between the lessees of the church lands and the new owners of such lands. To correct these evils the 32 Hen. VIII. c. 34, was passed, which gave to the grantees of reversions generally, and to the grantees and patentees of the crown, the same advantages and remedies as were possessed by the original lessors or grantors of the land. The statute placed the parties to whom it applied in the position of those who were privy to the original contract. To covenants, however, merely collateral, the statute does not apply; that is, if the covenant is beneficial to the lessor, without regard to his continuing the owner of the estate, it is a collateral covenant, upon which the assignee of the reversion cannot sue. The assignee of the reversion, however, is entitled to the benefit of all covenants entered into by a lessee with the lessor, his heirs and assigns, provided such assignee be the owner of the reversion immediately expectant on the term, and provided the estate he has be the same estate which, or a portion of which, the lessor had at the time of granting the lease. If there be a title paramount by escheat or otherwise, the covenant is at an end, if such title defeats the lessor's estate.

It was a common practice, in order to secure the performance of a covenant, to take a bond as an additional security. It enabled the obligee to elect between an action of debt for the penalty of the bond, or to proceed upon the covenant. The reason of the practice was, that at common law a devisee of the real estate of the covenantor was not liable to an action for a breach of covenant, though by the statute of fraudulent devises (3 Will. and Mary, c. 14), he was liable to an action for breach of the condition of the bond. This is now remedied by the 1 Will. IV. c. 47, which extends the provisions of the 3 Will. and Mary to the case of a covenant.

By the 3 & 4 Will. IV. c. 42, actions on covenants must be brought within twenty years after the cause of action has arisen.

Covenants may be discharged by a release, by their performance, by the destruction of the seal, or by the destruction of the interest upon which the covenant depends. They may be void at the time of their creation upon account of the personal incapacity of one of the parties to contract, as being an idiot or a lunatic, or upon account of their object being illegal, as relating to bribery, gaming, illegal insurances, lotteries, sales of offices, simony, smuggling, stock-jobbing, usury, or to wagers. They will also be void if opposed to public policy, as not to trade generally, though a covenant not to trade in a particular place, or with a particular person, would be valid.

COVENANTERS. [Cameron, Richard, in Biog. Div.]

COVERED-WAY, a road surrounding a fortified post along the side of the ditch which is opposite to the ramparts. It is usually about 30 feet broad, on the level of the natural ground, and is protected by the mass of earth called the glacis. Its situation is indicated by the unshaded space above the line r r in the article Bastion (*fig.* 1). As the works of a fortress form a series of angles which are alternately re-entering and salient, the covered-way necessarily changes its direction at each angle; and the spaces which are there formed by its branches (as at l and above the curve line at e in the article and figure above cited) are respectively designated "re-entering and salient places of arms."

Under the name of *orlo* the covered-way is met with in the writings of the first Italian engineers, and it is said to have been invented by Tartaglia in the 16th century.

In the defence of a fortress this work is of great importance. A constant fire may be kept up from thence while the trenches of the besiegers are being slowly executed on the surface of the glacis; and in the systems of Vauban and Cormontaingne it is purposely made so narrow as to render the construction of a breaching battery upon it impossible, except by the tedious operation of removing a large part of the glacis.

The covered way also affords the besieged opportunities of forming under cover, from which they can issue in large bodies for a sortie with an extended front, and having accomplished their object, or been driven back, retire to and cover their re-entry into the place while defiling through the narrow posterns and crossing the ditch, of necessity a work of time. Without the covered-way, troops making a sortie would, after having crossed the ditch, be scarcely capable of deploying under the fire of the enemy; and, in retreating, if pursued, they might be cut in pieces on the counterscarp before they could descend into the ditch, or gain, by the bridges, the posterns of the fortress; whereas by the sally-ports, or by steps temporarily formed along the interior side of the glacis, the departure from, or the return to, the covered way is readily accomplished by a large body of troops.

An attack on the covered-way is, moreover, a difficult enterprise, and is usually attended with great loss to the besiegers; the thickness of the glacis renders it impossible to facilitate the assault by forming a breach in it; a grazing fire of musketry from the covered-way disorders the assailants during their approach; and, when arrived at the crest of the glacis, one, and sometimes two, rows of palisades form a serious impediment to a descent into the work. Even if an entrance should be gained, the assailants are confined between the traverses and annoyed by the fire of the defenders who have retired behind them, or by a plunging fire from the parapets of the fortress. It is easy to conceive, therefore, that such an attack will scarcely be made unless those fires have been previously in part silenced, and the palisades in the covered-way deranged by a fire of guns or howitzers from the enfilading batteries.

COVERTURE. [Wife.]

COW, one of the most useful of the domestic animals. Her milk is peculiarly adapted to nourish infants and invalids, and requires no preparation to make it palatable or wholesome. In the article Cattle, we have given an enumeration of the various breeds of cows; and under Butter and Cheese an account of their principal produce. We shall here confine ourselves to the proper management of a cow, so as to make her most productive; and to the most common diseases to which this animal is subject.

Where only one or two cows are kept, especially where they are to be maintained on a limited portion of pasture, it is of great importance that a good choice be made when they are purchased or reared. Some breeds no doubt are much superior to others; but as a general rule, there is a better chance of having a profitable cow, if she be reared on the land on which she is to be kept. When the common breed of the country is decidedly inferior, it may be profitable to bring a cow from a distance, in which case it should be from some district of which the pasture is rather inferior to that to which she is brought, or at least not better. The best breeds are found in the richest pastures, but they do not thrive on worse. On poor land a small active cow will pick her food and keep in condition, where a fine large cow would starve, or at least fall off rapidly. This is particularly the case in the mountains, near the tops of which no domestic animal will live but the goat, and next to it the smallest breed of cows. Where the pastures are poor but extensive, cows give little milk, and the number which can be kept must make up for the produce of each. Where, on the other hand, cows are stalled, as in Flanders, and fed on artificial food brought to them in sufficient quantity, large bulky cows give the best return for the food; at least, this seems to be the opinion of the Flemish farmers in general. In France, where the cows are led along the roads to pick up the herbage growing by the road-side, or are tethered on a small portion of clover or lucern, a small lean cow is preferred; and in general the cows commonly met with, and which are bred in each district, seem the best adapted for the mode in which they are fed. Whatever be the breed or quality of a cow, she should always have plenty of food, without which no considerable produce in milk can be expected. This food should be succulent as well as nourishing, or else fat will be produced instead of milk. A cow well fed may be safely milked till almost within a month of her calving. It is better that she should be dry before the new milk begins to spring in her udder. A little attention will readily prevent her becoming dry too soon, or being milked too long. Heifers with their first calf should be allowed to go dry sooner than older cows; because their growth would be impeded by the double drain of the milk and the calf. It is best to let a heifer go to the bull when nature prompts her to it, provided she be not less than fifteen or eighteen months old; for if they are thwarted in their first heat, they are apt to become irregular ever after; and it is advantageous for a cow to calve regularly at the same season of the year. The best time is May, when the grass begins to be succulent. In some countries, such as Switzerland, the cows calve regularly in April or May, and are then sent to the pastures among the mountains. The calf is killed almost immediately, unless it be reared for stock, veal being of little value. In populous countries where veal is considered a luxury, the calves are kept and fattened by letting them suck the cows, or by giving them warm milk to drink. Near large towns this is a profitable mode of employing the milk, when it cannot be sold for immediate consumption.

A cottager with two or three acres of moderate land may keep a cow, and thus add much to his earnings as a labourer. For this purpose he will require a small portion of permanent grass fenced off, to allow the cow to take exercise, which is necessary to her health. Her food must be raised in regular succession, and cut for her. The earliest green food is rye; then tares; then clover, which may be made so to succeed each other as to give an ample supply. Cabbages, beet-root, parsnips, potatoes and turnips will continue the supply during winter; and the dung and urine of the cow carefully collected, will be sufficient to keep the land in condition. This system, when lately introduced into some parts of Ireland, greatly improved the condition of the industrious poor. There is very good advice on this management in Cobbett's 'Cottage Economy,' a useful little publication.

Where cows are allowed to be in the open air, with proper shelter in case of stormy and wet weather, they are subject to few diseases. They must be carefully looked to at the time of calving, but except in urgent cases nature must be allowed to perform her own office. A little common sense and experience will soon teach the possessor of a cow to assist nature, if absolutely necessary; and in case of difficulties the safest way is to call in an experienced person. Drinks and medicines should be avoided; a little warm water, with some barley or bean meal mixed with it, is the most comfortable drink for a cow after calving. The calf, and not the cow, should have the first milk, which nature has intended to purge its intestines of a glutinous substance which is always found in the new-born calf. A very common disease with cows is a disordered function of the liver, producing a yellowish tint in the eyes, and sometimes in the skin. A gentle purge, consisting of half a pound of Glauber salts, an ounce of ginger, and two ounces of treacle, with two quarts of boiling water poured over them, may be given when it is milk-warm, and repeated every other day; keeping the cow warm, if it be in winter, by a cloth over the loins, and in a shed. This will in general restore her health. Should the cow appear to have a chronic affection, the safest course for a cottager is to part with her at any price to those who may be better skilled in curing diseases; for it is seldom that a cow is worth the expense of the farrier's attendance in such cases. The symptoms of a diseased liver or lungs in a cow are leanness, with a staring coat, a husky cough with loss of appetite, a difficulty of breathing, and a great diminution in the secretion of the milk. The first loss by the sale of the cow is always the least in the end. In accidents, or acute diseases, the attendance of a clever veterinary surgeon is indispensable.

Nothing is more prejudicial than the idea that medicines are necessary to keep cows in health; and the practice of keeping advertised medicines at hand to give to an animal whenever it is fancied to be ill, is very detrimental to their health. Attention to food and exercise, giving the first regularly and in moderate quantities at a time, and allowing the cow to use her own judgment as to the latter, are the great secrets of health; and a healthy young cow reared at home, or purchased of a conscientious dealer, will probably live to old age without ever having had any disease. A cow is old and unprofitable when she reaches twelve or fourteen years. She should then be sold and a young one purchased. If the cottager have the means of rearing a cow-calf to succeed the old mother, he will do well; if not, he must lay by a portion of the cow's produce every year to raise the difference between the value of the old cow and a young one. The saving banks are admirable institutions for this purpose: a few shillings laid by when the produce of the cow is greatest, will soon amount to the sum required to exchange an old one for a younger.

Calf.—The rearing and fattening of calves is a very important part of rural economy, and on the care with which this is done depends much of the profit of grass-land in particular situations. In the dairy districts the milk is so valuable, that calves are got rid of as soon as possible. In some countries they are killed when only a few days old, and the flesh is of little value, being very soft and tasteless. In others the flesh of very young calves is considered unwholesome, and penalties have been imposed on those who kill a calf before a certain age. This is the case in France and Switzerland, where ten days is the earliest time at which a calf is permitted to be killed for sale.

Wealth and luxury have introduced a very different mode of proceeding in England. Calves are suckled with great care, and allowed to take as much milk as they can swallow, in order to make them fat, and their flesh white, firm, and delicate. The price at which a fat calf is sold, when ten or twelve weeks old, is often much greater than he would fetch at twelve months, if reared in the common way. It is chiefly in the neighbourhood of large towns that the practice of fattening calves is profitable. The calf-dealer buys calves in the dairy districts, and sells them again to those who suckle them. The animals are carried to a great distance in carts made purposely flat and shallow, their four feet tied firmly together, and their heads hanging over the back and sides of the cart. In this position they remain whole days without food or drink, and when they arrive at the place of sale they are so weak and attenuated that many of them die; and all of them require the greatest care and attention for several days before they recover sufficient strength to bear their natural food. If they are allowed to satisfy their appetite at first they invariably *scour*, that is, purge violently, and die. If the strong astringent medicines sold in the shops for the scouring in calves is given to them in this weak state, it only accelerates their death. The best remedy is to boil the milk for them, and give them little at first; to mix some starch or arrowroot with it, and to give them a raw egg beat up in milk. This restores the strength of the stomach, and generally cures them. When the calf begins to thrive on the milk which he sucks, or which is given him warm from the cow, nothing more is necessary than to keep him extremely clean and dry, to give him plenty of air, but not much light, and never to disturb him between his meals, which are generally twice in the day, at the usual time of milking the cows. Where it can be conveniently done, it is better to let them suck three times a day. If one cow does not give sufficient milk to satisfy the calf when he begins to get large, another cow must be at hand. Where a number of calves are fattened at once, and no butter or cheese is made, the number and age of the calves must be regulated by the number of cows and the quantity of milk which they give, so that there shall be milk enough for all.

The calf-pens should be made like narrow stalls, each for the accommodation of only one calf, just wide enough to allow him to lie down, but not to turn about and lick himself, which, if it become a habit, will much retard his progress in fattening. The bottom of the pen should be paved with brick, and washed clean morning and evening—or it should be boarded; the boards should be six inches from the ground, and have holes bored in them to let the urine drain through. A piece of chalk or powdered limestone is frequently put in a small trough, which the calf licks, and thus corrects the acidity which is apt to generate in the stomach. The common notion that it makes the flesh whiter is a mistake, except so far as good health in the calf produces whiter flesh. At five or six weeks old, if a little sweet hay is tied in a small bundle with a string and hung before them, they will pick a little of it; and by thus exciting the saliva the digestion will be assisted. It is only by minute attention that the suckling of calves can be made more profitable than the making of butter or cheese. When it is well managed, and the price of veal is about one-half the price of butter by the pound, there is an advantage in suckling, but otherwise making butter is more profitable.

Calves should be fat by eight or nine weeks old, and it is seldom advisable to keep them above twelve weeks. When they get large they take a much greater quantity of milk, in comparison with what they do at seven or eight weeks old, to produce the same increase of flesh. A calf of 16 or 18 stones (8 lbs. to the stone) the four quarters, and well fatted, will always sell better than one that is larger.

When milk is scarce, and the calves have not enough to satisfy them, it may be necessary to give them some substitute, such as meal mixed with warm milk, or balls of meal and water with a little gin in them, which makes them drowsy. Linseed made into a jelly with boiling water and mixed with warm milk is given by some, or powdered oil-cake. All these substitutes can only be recommended when the milk fails—they deteriorate the flesh more or less. The best plan, in such a case, is to sell the largest calves and reduce the number, so that they may all have their fill of milk. The weight of the four quarters of a calf when killed is about six-tenths of its live weight. Thus if a live calf weighs 200 pounds, his four quarters when he is killed will weigh $20 \times 6 = 120$ pounds.

When calves are intended to be reared for grazing or for the dairy, the most perfect individuals should be chosen. They should be well examined, especially the cow calves, to ascertain whether they have a perfect udder and teats, a broad pelvis, and good lungs. If any deficiency appears, they ought to be sold or fattened. They should be allowed to suck the mother three or four days, but no more, and then be taught to drink milk out of a pail. This is soon accomplished by gentleness and care. Should there be any difficulty in teaching him to suck with the hand in the usual way, a wisp of twisted straw is put into the pail and one end of it in his mouth. This seldom fails to bring him to drink. When the calf is a week old, skimmed milk which has been boiled and allowed to cool again, so as to be milk-warm, may be given him. After a time this may be diluted with water, and a little meal stirred into it; or some thin gruel may be made to which skimmed milk is added. Carrots or turnips make an excellent food for calves, especially if they are boiled with cut hay and given warm. In this way calves may be reared with very little milk, till they can live on grass alone. A bull-calf not intended to be kept as a bull, may be castrated when three months old.

The diseases of calves are chiefly *scouring* and *constipation*; for the first, if the calves are strong, a recipe recommended by Clater, consisisting principally of prepared chalk, is likely to be of service: a large table-spoonful of the powder is given in a pint of new milk every night and morning before the calf is fed, until the purging ceases. For costiveness the following is a good and safe remedy: Castor oil one ounce, prepared kali half a drachm, ginger in powder one tea-spoonful. Mix these for a dose, and give it in half a pint of warm milk.

COWPOX. [Small-pox.]

COWRY SHELLS are called by conchologists *Cypræa*. Their beauty has procured them a place among the ornaments of our chimney-pieces, and they have been in demand among civilised and uncivilised nations time out of memory. Like the precious metals, they are not only used for ornament, but they have also the qualities necessary to constitute them a species of currency. In fact, cowries (the *Cypræa moneta*) are used as small coin in many parts of Southern Asia, and especially on the coast of Guinea in Africa. Their great multiplication in these countries, and the extension of the knowledge of coin, has, however, depressed their value so much that they are now used only for domestic interchange, or for the purchase of trifling articles of less value than any European coin. [Money.]

The shells used as currency occur principally in the Philippine Islands, and on the coast of Congo, but particularly among the Maldive Islands, of which they constitute the principal article of export. They are fished for three days after the high tides, by the women, with baskets, in which they take up a quantity of sand containing cowries. When the sand is washed out, the shells are heaped up on the shores, and the fish soon die; they are then ready for the market. [Cypræidæ, in Nat. Hist. Div.]

CRAB. A machine used in building operations, for hoisting heavy loads. It consists of a wooden frame, forming a wide base able to be weighted in such a manner as to keep the machine steady; and of vertical side frames, which are usually of open cast-iron work, and which carry the seats or bearings for the barrel and winches, set in motion by means of double handles on the end of the winch shaft. The winch is, in fact, a pinion gearing into a toothed wheel, with either a single or double purchase, upon the edge of the barrel wheel; and around the latter the fall, or chain, which raises the load, usually by the interposition of a series of blocks, is wound. Single purchase crabs are rarely able to lift more than two tons; whilst the ordinary double purchase crabs, worked by four men at the wheel, are able to lift as much as from six to eight tons by passing the fall through a series of one, two, and three sheaved blocks.

CRADLING. A wood, or iron frame intended to receive and bind together the materials used to form a solid bed, or landing; occasionally also cradlings are used to support groined arches, but the principle on which they act is in all cases to form, as it were, the skeleton around which the detached materials are made to adhere to one another. The joists of wrought iron, subsequently filled in with cement concrete, which have lately been used to form fire-proof floors, serve actually as cradling; and the iron frames used by the French builders in the construction of their pottery floors and roofs, serve the same purpose. The mode of constructing a cradling must of course depend upon the load it will have to carry, the materials of which it is composed, and the position in which it is placed; and the only general practical remark to be made on the subject is that attention must be paid to obviate any inconvenience from the expansion of the various materials employed, whether that expansion arise from heat, or from the mere crystallisation of the mortars, cements, or plasters. (See Eck. 'Traité de Construction en Poteries et Fer,' Paris, 1841; 'Papers of Royal Inst. of Brit. Architects,' January, 1854.

CRAMP. [SPASM.]

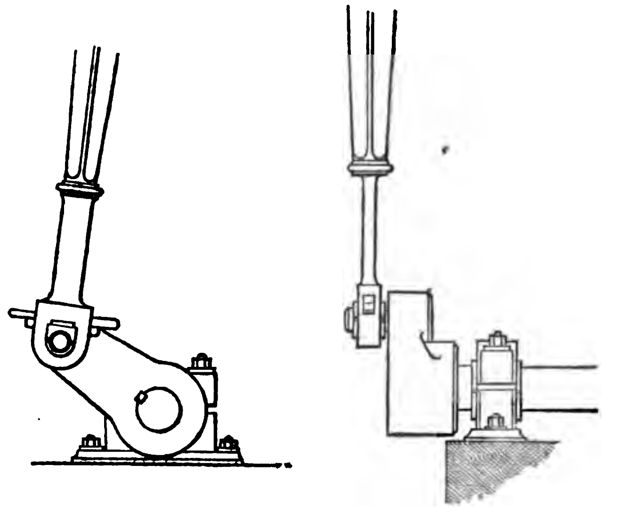
CRAMP. A small piece of metal used for tying together the building materials of large dimensions which cannot be bound by the mere adhesion of the cementitious substances with which they are bedded. Cramps are made of iron, of copper, or of gun metal, and they are run with lead or with sulphur, or cement, according to the position they are used in; their form is either that of a flat piece of metal with the two ends turned downwards, thus ⊓ or it may be simply a flat piece of metal made to present a double wedge on plan thus ⋈. As iron is liable to absorb moisture, even in the interior of a stone, and then to pass into the state of the hydrous oxide, a process always accompanied by an increase of volume, it is advisable only to use iron cramps when the stones they are intended to connect have a considerable thickness; and for thin ashlar work copper or gun-metal cramps should alone be used. In marble works copper cramps are preferable, but they must be run with plaster, or sulphur.

CRANE. A machine used in building, and in ordinary commercial operations for the purpose of hoisting weights. It may be described as consisting of an upright post, bearing a projecting arm or *jib*, usually stiffened by a bracket; and a barrel, winch, pinion, and handles, to receive a fall passed over a sheaf at the head of the jib, and reeved into the block which bears the hook on which the load is ultimately brought. The upright post is, generally speaking, made so as to be able to revolve on its centre, and thus an article raised at any one point may be deposited at any other point within the sweep of the jib. Cranes are made either fixed or movable, single or double; as *pit cranes*, or those which have their foundations below the ground; or as *derricks*, or those which have their framework and stays above the surface.

Cranes differ from crabs in this respect, namely, that in consequence of their possessing jibs, the former are able to deposit their load where it may be desired; whereas crabs can only deposit their load vertically, under the last block connected with them.

CRANIOLOGY. [PHRENOLOGY.]

CRANK. A portion of machinery used, together with a connecting rod, for the purpose of converting rectilineal into circular motion, or *vice versâ*. Thus, in an ordinary steam-engine the upward and downward motion of the piston is made to give a circular motion to the crank, by the interposition of the connecting rod, which bears joints at its respective ends; and then the upward motion of the piston causes the crank to pass over half of its circle of revolution, whilst the downward motion carries it over the remainder of its path. Evidently in such an arrangement there must be two points, that is to say, when the piston is respectively at the top and bottom of its stroke, wherein it exercises no power over the crank; and when the crank is upon the horizontal line passing through its own axis the power exercised upon it is the greatest. It is for the purpose of carrying the crank over these dead, or weak points that the fly-wheel is introduced into the construction of engines, and numerous other contrivances have been suggested with a view to reduce or annihilate the irregularity of the action, without, however, producing any practical improvement; so that at the present day the constructors of machinery continue to use the crank and connecting rod in the majority of cases wherein they desire to convert perpendicular into circular motion. In the treatise on the Steam Engine, by Mr. J. Scott Russell, Edin. 1841, the question of the supposed loss of power by the use of the crank is very ably discussed. See also Hann and Gener, 'The Steam Engine,' 8vo, London, 1854; Moseley's 'Mechanical Principles of Engineering and Architecture,' 8vo, Lond. 1843.



[Front view. [Side view.]

CRAPE is a light transparent fabric composed of silk, from which, by the mode of its preparation, all the gloss has been taken. When dyed, as it usually is, of a black colour, it is worn as a material for mourning dresses.

The weaving of crape is conducted at a hand-loom, according to the simplest method of the weaver's art: all its peculiarity being given to it in the dressing, which it receives after it is taken from the loom. The silk is used without having been washed or dyed, and consequently with all the natural viscid gum which forms a part of its composition as spun by the worm. For thin crape, the only preparation which the filaments undergo previous to the weaving is the simple twisting, which forms the first process of the throwing mill, and in which state the thread is technically called *singles*. When it is intended to make a more substantial fabric, the warp is formed of two and sometimes three filaments twisted together, which in that state are called *tram*: the weft is still composed of singles. After the web is taken from the loom, it is dressed with a viscid solution of gum, which in drying causes the individual threads to resume, as far as the interlacing will admit, the form they originally held previous to their being twisted in the throwing mill; it is by this means that is produced the peculiar wrinkled appearance by which crape is distinguished. This fact will be shown if a piece of crape is washed in water hot enough to discharge the gum, when the web will resemble thin gauze.

CRAYONS (from the French *crayon*, derived from *craie*, chalk) are a species of material for drawing. They may be classed in two kinds, native and artificial. The principal native crayons are black, white, and red. The best black is procured from Italy. It is a species of earth, which is soft in the ground, but hardens on exposure to the air. It is of a bright even tint, and of a smooth and moderately hard texture. Admirably adapted to outlining and shading drawings of any size, it is to the artist an excellent tool for study. It will form a large, bold, and strong line, and is at the same time capable of great fineness. The best white is a pure chalk, and is procured in France. It is of a brilliant colour, but very brittle; so that it is difficult to avoid breaking it frequently. There are various modes of correcting its brittleness, such as soaking it in milk, baking it on hot iron, or in the fire; but they all, more or less, injure the brilliancy of its tint. Pipeclay is sometimes employed as a substitute, as being smoother and less brittle; but it is of a very inferior tint. White chalk is used on tinted paper to touch on or hatch the high lights. It is also much used by the painter to determine or correct his outline. Red chalk is employed in the place of black chalk on white or tinted paper, because it is freer than the best black chalk, and firmer and smoother than the inferior kinds. It is also of a warmer and more agreeable tone of colour; but it is by no means capable of the same degree of fineness in small or highly finished drawings; it is a clayey ochreous substance. All these three kinds of native crayons are frequently combined in the same drawing, on tinted papers, which are generally of a neutral gray, of a bluish, greenish, or brownish quality.

The native crayons are the legitimate materials for the artist in the study of drawing, and in tracing the first thoughts of design. Some of the sketches of Raffaele, Michel Angelo, the Caracci, and others of the great painters, remain to attest the utility of crayons in forming the style of a painter or sculptor, and their capability of expressing the highest qualities of design.

Artificial crayons are composed of different coloured earths, and other pigments, rolled into solid sticks with some tenacious stuff such as milk, common gin, or beer-wort. The best are procured from Switzerland; but very excellent academy crayons are made in this country, and in Germany. Those made in Germany are most suited to large works, such as studies for fresco paintings, &c. Artificial crayons are employed in crayon painting upon a ground composed of paper or vellum, stretched upon a canvas, which has been previously extended on a deal frame. It is requisite to paint with cooler tints in crayons than in oils, which is the reason why crayon painters generally fall into such a cold style of colouring when they work in the other material. Great softness and delicacy and great vivacity of tint may be obtained in finished crayon paintings; but depth, richness, and truth of colour, are not obtainable, nor solidity in the forms. Moreover, the delicacy proper to the substance is tolerably certain to betray the artist who devotes himself solely to its use into a petty and weak style of drawing. For sketches of portraits, in which the form and expression, and a general idea of the complexion, are all that is required, crayons are a pleasing and useful material; but they should be employed only occasionally, and as a variety to other modes of study.

Considered as a branch of manufacture, crayons, as we have stated above, have been more carefully attended to by the French than the English. There are many recipes for the preparation of them: spermaceti, bone-ash, and boiling water; pipeclay, prepared chalk, colouring matter, and pale mild ale; white soap, rectified spirits of wine, washed clay, chalk, colouring matter, and boiling water; pure clay, shellac, spirits of wine, oil of turpentine, and colouring matter; fine pale blue clay, shellac, wood naphtha, and colouring matter: all are recipes in practical use. The colouring matter differs greatly in kind; mere difference of *tint* is produced by diluting with washed chalk; but difference of colour depends of course on the pigment mixed with the substance of the crayon. Thus, for black, are used black lead, ivory black, and lamp black; for blue, indigo, smalt, verditer, and Prussian blue; for brown, umber and terra di Sienna; for green, mixtures of blue and yellow; for yellow, king's yellow, Naples yellow, orpiment, and yellow ochre; for red, carmine, vermilion, hæmatite, red chalk, and red lead; for purple, blue mixed with carmine or vermilion. In making crayons, the manufacturers generally employ a metal cylinder, two or three inches in diameter, open at one end and having a perforated bottom at the other. The perforations are equal in size to the intended thickness of the crayon. The composition, in the state of a stiff paste, is put into the cylinder, and is forced down by a plug or piston; it exudes through the holes, and is cut off into convenient lengths.

Crayons for writing on glass are made of French chalk; or of a mixture of spermaceti, tallow, wax, red lead, and carbonate of potash. Crayons for writing or drawing on stone are made of two or three different mixtures: tallow, soap, white wax, and lamp black; tallow soap, white wax, shellac, and lamp black; white wax, spermaceti, hard soap, and lamp black; &c.

An instrument called a portcrayon is employed to hold the crayon by. It is a metal tube, split at each end, so as to gape a little to admit the crayon; a sliding ring embraces the tube, and may be made to close the disparted sides firmly upon the crayon.

A stump, made of leather, cork, or paper, closely rolled, or cut into a short round stick, more or less sharply pointed at each end, is used to soften and spread the chalk or crayon in the shaded parts of the drawing.

CREAM. [BUTTER.]

CREAM OF TARTAR. [POTASH, *Bitartrate of.*]

CREAMS. Creams, in the language of the confectioner, are compounds of cream, or sweetened water, or egg and milk, with various flavouring vegetable juices, congealed by ice, or by a freezing mixture. The flavouring agent may be almond, chocolate, coffee, lemon, orange, pistachio, raspberry, taraxacum, vanilla, &c. Ices, creams, and ice-creams differ a little in their mode of preparation, but scarcely at all in their ingredients.

CREASOTE or KREASOTE ($C_{16}H_9O,HO$?) (from *κρέας*, "flesh," and *σώζω*, "to save,") is a fluid compound of oxygen, hydrogen, and carbon, obtained by Reichenbach. This substance exists in crude pyroligneous acid, but it is best prepared from that portion of the oil distilled from wood-tar which is heavier than water. The operation is too complicated to admit of its being stated at length. The properties of creasote are the following: It is a colourless transparent fluid, and has a strong odour which greatly resembles that of smoked meat, with a caustic and burning taste. Its specific gravity is 1·037; it boils at 397°, and remains fluid at 17° below zero. It requires 80 parts of water for solution, and is soluble in alcohol, ether, and sulphuret of carbon, in all proportions. It burns with a sooty flame, refracts light powerfully, and is a non-conductor of electricity; it has neither acid nor alkaline properties. It is highly antiseptic, and hence the name given to it. It combines both with acids and with alkalies; but it is decomposed by strong nitric and sulphuric acid.

Creasote coagulates albumen, even when much diluted, and it also coagulates serum. Meat and fish are preserved after having been brushed over with creasote and dried in the sun; the antiseptic power of pyroligneous acid and wood-smoke is supposed to be derived from its presence. A few drops added to ink are said effectually to prevent its becoming mouldy.

CREASOTE or KREASOTE, *Medical Properties of.* The chemical formula shows that creasote contains a very large proportion of carbon; which circumstance, along with other peculiarities, renders it in certain cases a valuable medicine, and in other instances a formidable poison. The introduction, by its means, of a large quantity of carbon into the body, produces all the bad effects which an excess of that principle in the animal system is known to occasion; while in certain morbid states of the system, this increased quantity of carbon produces the remarkably sedative effect which has followed its use. There can also scarcely be a doubt that the highly carbonised nature of this compound, along with its power of coagulating albumen, is the source of the powerful antiseptic properties which many of its combinations and solutions have been known for ages to possess. Independently of its general action on the system when taken internally, it produces, when concentrated, a local effect on the part to which it has been applied very necessary to be borne in mind, and which probably is owing to the power which creasote seems to possess of coagulating the albumen, even of living as well as of dead tissues, and which it is enabled to reach by destroying the epidermis of the part which it has been allowed to touch. Dropped upon the tongue it causes violent pain; unless largely diluted it cannot be swallowed, as, independent of the pain, it coagulates the albumen of all the fluids with which it comes in contact. Fibrine, carefully separated from other principles, is not affected by creasote.

A few drops of a very dilute solution of creasote taken into the stomach causes a sensation of warmth, and if repeated at short intervals, or the dose gradually increased, giddiness and other signs similar to those of intoxication are experienced. The urine is frequently observed to acquire a black hue, "as if a small quantity of Indian ink had been added to it, perfectly transparent, and without sediment." ('Medical Gazette,' vol. xvi. p. 599.) In larger doses it has all the effects of a narcotico-acrid poison, the venous state of the blood producing on the brain a markedly sedative effect, and the respiration becoming slow and laborious, or convulsive. Animals, fishes, and insects, plunged into creasote water speedily die with strong convulsions. Even plants watered with it perish, except perhaps those of the tribe Ericaceæ, which constitute the chief vegetation of bogs or mosses. The injurious action of the smoke of towns on plants has been ascribed to the creasote it is supposed to contain. But mechanical impurities have a far larger share, as is proved by the utility of Ward's cases.

Creasote has been recommended as a remedy in very many diseases, in few of which will it ultimately be found useful. Vomiting, including sea-sickness, some forms of bronchitis, cutaneous diseases, and hæmorrhage either spontaneous or from wounds, are the only cases in which it has a claim to confidence. Vomiting, such as frequently occurs in hysterical and other persons from irritation of the origin of the eighth pair of nerves, will almost invariably be alleviated or checked; also that in sea-sickness, which proceeds from a similar cause, may be lessened, but scarcely any other kind of vomiting can be relieved by it. That form of vomiting which occurs towards the end of phthisis pulmonalis, and is connected with subacute inflammation of the stomach, is sure to be aggravated by it; as will any other, either caused by scirrhus, ulceration, or any crude indigested matter in the stomach. The utility of breathing the vapour of tar-water in some forms of bronchitis often mistaken for consumption, has long been known: but creasote can be of no service in true tubercular consumption, when cavities exist in the lungs. Glanders in the human subject has been cured by injections of creasote thrown up the affected nostril. (Dr. Elliotson.) Creasote possesses great influence over external ulcers when it can be applied sufficiently strong to coagulate the albumen and so form an artificial skin, under which the healing process goes on kindly. Thus in porrigo, especially ringworm of the scalp, and psoriasis, it is unrivalled. But poisoning has resulted even from its external application. Its power of coagulating the albumen of the blood renders it a most valuable styptic, and it may be employed to stop the bleeding mouths of even the largest arteries, such as the carotid, during surgical operations, or the flow of blood from leech-bites. In case of poisoning by creasote, moderate venesection and artificial respiration may be employed; the latter should be continued till by the operation of the lungs, the liver, and the kidneys, the system can free itself from the hurtful excess of carbon. The solution of creasote should always be prepared of a definite strength, to prevent unfortunate occurrences from an over dose. Creasote is now extensivily employed to preserve anatomical preparations for museums. It is likewise fraudulently added to whiskey to give the *peet-reek* flavour which many like.

CREATINE. ($C_8H_9N_3O_4$2Aq.) This body, originally discovered by Chevreul, occurs in transparent very brilliant crystals. It has a bitter strongly pungent taste, and irritates the pharynx. It dissolves in 74 parts of cold water, and in boiling water in such quantity that on cooling the solution becomes consolidated into a mass of glistering needles. It dissolves sparingly in alcohol, and not at all in ether. It forms no definite salts with acids. According to Liebig it is best obtained from finely chopped flesh that has been well kneaded with water, and the fluid removed by pressure. The coagulable matters are then removed by boiling, and the phosphates by caustic baryta. The fluid left is then evaporated till the creatine is deposited in the form of needles. Creatine can also be obtained from the urine. It appears to be produced in the flesh of animals as the result of a process of retrogressive change in the elements of the tissues in which it is found. It is in fact a product of excretion.

CREATININE ($C_8H_7N_3O_2$) was discovered by Liebig. It is obtained from creatine by the action of hydrochloric acid. It is found also in the muscles and the urine, with creatine, whilst these bodies are in their normal condition. But in putrid flesh and urine no creatine is found. Hence creatinine may be regarded as the result of the decomposition of creatine.

CREDENTIALS are the instruments which an ambassador or other diplomatic minister receives from his own government, authorising him to appear in his diplomatic character, defining the extent of his powers, and showing to what rank of ministers he is intended to belong. The credentials are usually in the form of a closed letter, addressed to the power to which the minister is sent; but ministers are sometimes accredited by letters patent, which is the form commonly adopted when they are to be sent to a congress.

A minister cannot be received in any other character than that which is given him by his credentials; and for this reason he usually communicates their contents before he is admitted to his first audience. If he is accredited by letters patent, this is done by showing the instrument itself; but if his credentials are sealed, then by presenting a copy of them.

The powers granted by the credentials may either be confined to certain specified transactions, or extend generally to all negotiations whatever; and may, in either case, be either limited or unlimited; in which latter case the minister is styled a minister with full powers, or minister plenipotentiary.

(Vattel, *Droit des Gens*, liv. iv., § 76; Klüber, *Droit des Gens moderne*, §§ 193, 194.)

CREDIT. [Bill of Exchange; Currency.]

CREDIT, LETTER OF, is an order given by bankers or others at one place to enable a person to receive money from their agents at another place. The person who obtains a letter of credit may proceed on his journey, and need only carry with him a sum sufficient to defray his expenses; he even derives from it some of the advantages of a banking account when he reaches his destination, as he may avail him self of it only for part of the sum named. If it were not for the convenience which a letter of credit affords, a person intending to make a tour, for example, on the Continent, would be under the necessity either of taking with him the whole of the money which he would require during his absence, or of receiving remittances from home, addressed to him at particular places.

This instrument is now subject to a stamp duty of one penny, except when it is sent by a person in the United Kingdom to a person abroad, authorising drafts on the United Kingdom. It is not a negotiable instrument. No one, therefore, can legally demand payment or give a valid discharge for the amount except the person named in it, or his agent duly authorised for that purpose; so that payment to any other is no discharge of the banker from his engagement thereon. At the same time there is no contract of the banker or his agents with the payee, so as to be liable for damages in an action instituted by the payee for having refused him payment, according to the tenor of the letter, unless indeed the payee in one locality happens to be the same person who in another purchased the letter for his own convenience. Where the payee and the purchaser of the letter are different persons, the payee's remedy in such a case is against the purchaser, to whom the banker is answerable for the default of his agents in not meeting the payee's drafts by prompt payment.

CREED, from the Latin *credo* (I believe), the English name for those short summaries of Christian doctrine which in the Continental churches are commonly called symbols, though sometimes, also, credos. The English Church adopts, as "thoroughly to be received and believed," the three ancient creeds, called the Apostles' creed, the Athanasian creed, and the Nicene creed, but only says of them generally, that "they may be proved by most certain warrants of holy Scripture." (Art. viii.) The Roman Catholic Church adopts along with these what is called the Creed of the Council of Constantinople, which contains some addition to what is said in the Nicene creed on the subject of the divinity of the Holy Ghost. Many other similar formulæ have been received at different times in particular Churches.

CREEK is a small inlet on a low sandy coast. Such inlets occur also frequently in harbours inclosed by a low shore and along the banks of rivers. Sometimes, especially in harbours, creeks are formed by the mouths of small brooks and rivulets. In large rivers creeks are resorted to by small craft as harbours or landing places, and they are often visited by fish in spawning time. In the United States the name creek is very generally applied to small *inland* streams, which in England would be called brooks or rivers.

CREEK INDIANS. [North American Indians.]

CREES AND CHIPPEWAYS. [North American Indians.]

CREMO'NA, a general name given to violins made at Cremona in the 17th century by the Amati family, and by Stradiuarius at the commencement of the 18th. These instruments excel all others, and the choicest of them bear very high prices. [Violin.] Cremona is a name erroneously given to a stop in the organ; it ought to be *Krumhorn*, a sort of cornet, of which it is intended to be an imitation.

CRENIC ACID ($3HO,C_{24}H_{12}O_{16}$). An acid found combined with ammonia in vegetable mould. It dissolves in water with a yellow colour, and, rapidly absorbing oxygen, becomes converted into a brown solution of *Apocrenic acid* ($2HO,C_{48}H_{12}O_{24}$).

CREOLES, a word originally Spanish, and used to designate the children and descendants of European parents, who were born in the South American or West Indian colonies, as distinct from the resident inhabitants born in Europe, as well as from the offspring of mixed blood, such as the Mulattos and Mestizoes, born of negro or Indian mothers. The Creoles of Spanish America were for a long time inadmissible to civil and political offices, as well as to the higher ranks in the army; and even after Charles III. removed their disqualifications, they were still considered as inferior to the native Spaniards. This state of humiliation contributed perhaps as much as the climate to render them lazy and indolent. The insurrection of the Spanish colonies made the Creoles masters of the country, from which the native Spaniards were mostly driven away. In the West India Islands the Creoles are upon an equal footing with European natives. The Creole women are characterised by the symmetry of their persons, the brilliancy of their eyes, and the sallowness of their complexions.

CREOSOTE. [Creasote.]

CREPUSCULUM. [Twilight.]

CREST, from the Latin *crista*, the ornament of the helmet: a term in heraldry sometimes used for the helmet itself. Hence, *to crest*, to adorn as with a plume or crest, in Milton, 'Par. Lost,' ix. 500.

"his head
crested aloft."

In speaking of the cimier or crest, says Dallaway ('Inquiries into the Origin and Progress of Heraldry in England,' 4to, Glouc. 1793, p. 386), "It will be necessary to describe the armour worn for the defence of the head, and the progressive embellishments which were added to its rude form, with the era of their invention. Montfaucon, that most critical antiquary, has preserved many delineations of the ancient Norman casque, which, when the whole body was invested in mail, was composed of iron framework, covered with leather, and quite flat at the top, to which shape succeeded the conical head. By the number of bars of which the beauvoir or visor consisted, when presented in front view, the rank of the wearer was ascertained; that of the esquire was always in profile and closed, to denote his vigilance and activity in battle. The date of the introduction of crests into England is uncertain. After the time of Richard I., some of the kings are represented with a crown as a sort of crest on the helmet. The seal of Edmund Crouchback, earl of Lancaster, exhibits the crest, accompanied by the lambrequin and wreath, prior to the year 1286. The crest is said to have been carved in light wood, or made of leather, in the shape of some animal, real or fictitious, and fastened by a fillet of silk round the helmet, over which was a large piece of fringed samit or taffeta, pointed, with a tassel at the end. Before figures were introduced, plumes only were used, as well upon the head of the horse as on that of the warrior, which we gather from the seal of Baron de Spencer in 1296." In 1322, Thomas, earl of Leicester, bore the figure of a dragon. "The principal application of crests was in jousts or hastiludes, when the shield was not borne, but where they afforded an equal distinction; or by the chief commanders of horsemen in the field of battle. . . . . Crests are not held to be absolutely hereditable, but may be assumed; and as females could not avail themselves of their primary use, accordingly no woman is allowed to bear a crest. As an appendage to sepulchral monuments, crests are placed beneath the head of the armed effigy, attached to the helmet by the wreath and lambrequin; and at the feet a lion or dog is added. Upon many of the large altar-tombs, so frequent in the 16th and 17th centuries, those both of the man and of his wife's family are carved at the feet of the recumbent figures." The wreath on which the crest rests was of silk, twisted of different colours, according to the fancy of the wearer. The position of the crest when the arms are blasoned varies with the rank of the bearer. Peers have the coronet on the shield, and the helmet and crest above the coronet. Commoners have the helmet and crest, with the interposing wreath, resting on the shield.

Instances of crests formed of feathers may be seen in that of Sir Henry Percy, in Edward I.'s time, engraved at the bottom of plate xxiv. of Meyrick's 'Critical Inquiry into Antient Armour;' and in that of Sir John Harsick, *t.* Richard II., 1376, in plate xxxvi. of the same work; and many such occur in the illuminations to the contemporary manuscripts of Froissart's Chronicle. The custom of conferring crests as distinguishing marks seems to have originated with Edward III., who in 1333 ('Rot. Pat.,' 9 Edward III.) granted one to William Montacute, earl of Salisbury, his "tymbre," as it was called, of the Eagle. By a further grant in the 13th of the same king ('Rot. Vasc.,' 13 Edw. III. m. 4), the grant of this crest was made hereditary, and the manor of Wodeton given in addition to support its dignity.

CRESYL ($C_{14}H_7$). The hypothetical radical of an alcohol, *cresylic alcohol*, or *hydrate of cresyl* ($C_{14}H_7O,HO$), found in some descriptions of commercial creasote prepared from coal tar.

CRESYLIC ALCOHOL. [Cresyl.]

CRE'TINS, a word of which the derivation has been disputed, but which is probably from the Romanesque *cretina*, a miserable creature; and the various names for the same class, trotteln, lallen, göcken, cagot, &c., all convey a similar meaning. In the Valais and other Alpine valleys, crétins are certain individuals who are more or less idiots, and most of whom have large swellings on their necks, called goîtres. The goître or wen is not, however, always a necessary sign of crétinism. The goîtres are of all sizes, from that of a walnut to the size of a quartern loaf. There are also various gradations of crétins; those in the lowest state of idiotcy cannot articulate distinct sounds, but make a sort of cry, or burst out into an idiotic laugh; they are as helpless as infants, and their intelligence seems below that of many brutes. Others are able to go about, and attend to some easy labour, and make themselves understood. They are numerous about the villages and hamlets of the Lower Valais and of the Val d'Aosta; they are not so common in the German part of Switzerland, where, in many of the valleys they are unknown; it is said that they are not found among the natives of the higher valleys or mountains; even in the Upper Valais, east of Sion, they are rare. Crétinism, however, is not confined to Switzerland, it prevails in Carinthia, in the valleys of the Pyrenees and the Apennines; in the Harz mountains; and, out of Europe, in Tatary, in the Ural mountains, in Bootan, Tibet, Sumatra, among the Cordilleras, and even in Africa, in Bambarra, and along the upper part of the Niger. Isolated cases are met with everywhere. There has been much discussion about the causes of this infirmity. In Germany great attention has been paid to the subject, and Dr. Röson (über Cretinismus und angebornen Blödsinn,' in a discourse delivered before the Natural History Society, at Eslangen, in 1841), attributes it sometimes to the state of health of the parents, but more frequently to atmospheric and climatial causes, and particularly to such sudden changes of temperature and of weather as are experienced in mountain valleys, in which also are commonly found morassy soils or stagnant waters; and above all, the nature of the water which is drunk. Attempts have been made to ascertain the proportions of crétinism on various geological formations; in Berne, crétins are most numerous in the Jura formation; in Austria they are stated to prevail most in those valleys resting on trapp, porphyry, or clay-slate. The disease does not appear to be generally born with the child, though sometimes scrofulous symptoms precede, but to develope itself between the second and sixth years of age, commencing by a softening of the bones, and an ever-increasing fatuity. These symptoms can, it is said, be sometimes removed or alleviated by early applied medical and moral treatment.

In Berne, an institution has been formed at Abendberg, for the reception and instruction, where possible, of the poor sufferers, under the management of its founder, Dr. Güggenbühl; who has contributed an interesting account of his proceedings, and of the various classes of crétinism, to the 'Deutschen Vierteljahrschrift' (Quarterly Journal of Germany), in 1845.

CRIMES AND PUNISHMENTS. The punishments under the criminal law had been greatly mitigated previous to 1840. In consequence of this, and perhaps still more from the establishment of an effective police in the metropolis by Sir R. Peel's Act, the 10 Geo. IV., c. 44, which has been gradually extended to the whole of Great Britain and Ireland, though the number of executions has declined, the number of commitments and the proportion of convictions have increased. In 1831 the number of commitments had been 19,647, of whom 3047 were females. Of these 13,830 had been convicted, and 1601 sentenced to capital punishments. Of these only 52 were executed, 12 being for murder. Up to 1834 there had been no classification of offences. From that year and subsequently they have been classed under the following heads, from which it will be seen that the increase of offences has been, in England and Scotland, chiefly in offences against property without violence: Class 1, offences against the person; 2, offences against property, committed with violence; 3, offences against property, committed without violence; 4, malicious offences against property; 5, forgery and offences against the currency; 6, other offences, not included in the foregoing classes. In 1835 there were 20,731 commitments, of which 2016 were under class 1, 1354 under class 2, 15,478 under class 3, 156 under class 4, 368 under class 5, and 1359 under class 6. Of the total 14,729 were convicted, of whom 523 were sentenced to capital punishment, and 34 executed, of whom 21 were for murder. In 1856, there were in England 19,437 persons committed for trial, of whom 15,425 were males and 4012 females; of these, 4672 were acquitted or discharged, and 31 were found insane; of the number convicted, 1264 were for offences against the person, 1787 for offences against property with violence, 10,487 for offences against property without violence, 94 for malicious offences against property, 757 for forgery and offences against the currency, and 345 for offences not included in the preceding classes, and including misdemeanors; 69 were sentenced to death, of whom 16 were executed; 57 were transported for life, and 216 for terms exceeding ten years; 2158 were sentenced to penal imprisonment for terms varying from four years to life; 11,865 were sentenced to various imprisonments, from one month and under to not exceeding four years; and in this class, in the terms between six months and one month or less, the numbers show a remarkable decrease from previous years; in 1856 the numbers were 7800, against 13,447 in 1855, and 16,509 in 1854; indeed it is by far the smallest amount in any year from 1847; 222 were ordered to be detained in reformatory schools, and 127 were whipped, fined, or discharged on sureties. The great decrease in the number of commitments is probably to be attributed in a considerable degree to the extended provisions of the Summary Convictions Acts. On summary proceedings, the number of cases under the Criminal Justice Act, was 11,272, and under the Juvenile Offenders' Act, 2031. Altogether there were 132,869 persons committed to prison, 99,336 of whom were males, and 33,363 females. The commitments were—19,278 for trial, 77,712 on summary convictions, 2794 for want of sureties, 13,952 remanded and discharged, 11,406 debtors on civil process, and 7557 under the Mutiny Act. The total shows an increase of nearly 4000 commitments over those for 1855: but there is a decrease of 7000 in the number of summary convictions. Of the committals, omitting debtors and military prisoners, which reduce the number to 113,736, 1990 were of children under 12 years of age; 11,991 of persons between 12 and 16; 24,868 between 16 and 21; 33,400 between 21 and 30; 20,973 between 30 and 40; 11,343 between 40 and 50; 5519 between 50 and 60; 2732 above 60; and 920 of whom the age was not ascertained. Of the whole, 37,686 could neither read nor write, 61,253 could read or read and write imperfectly, 6108 could read and write well, 318 had received superior instruction, and of 8371 the instruction was not ascertained. The county and borough prisons are stated to be constructed to contain 26,447 prisoners; the daily average of prisoners is 17,754, and the greatest number at one time was 22,035; but, though on the average there may be room enough, some prisons are terribly overcrowded.

In Ireland in 1856 the total number of persons committed or held to bail for trial was 7009, of whom 3075 were either acquitted or discharged. Of the number committed, 2063 were for offences against the person, 556 for offences against property with violence, 2884 for offences against property without violence, 78 for malicious offences against property, 75 for forgery and offences against the currency, and 1143 for other miscellaneous offences. Of those convicted only 8 were sentenced to death, and 3 only executed; 14 sentenced to transportation for life, and 372 to other periods of transportation or penal servitude; 2798 to various terms of imprisonment; and 832 were whipped or fined, or discharged on surety, or pardoned. In the same year there were 25,461 cases heard at petty sessions or before magistrates, and 9526 persons were imprisoned for drunkenness.

In Scotland in 1856 the total number of offenders committed for trial was 3713. Of these 1046 were for offences against the person, 380 for offences against property committed with violence, 1942 for offences against property without violence, 79 for malicious offences against property, 85 for forgery and offences against the currency, and 181 other offences not included in the preceding classes. Of the total number committed, 2723 were convicted, of whom 3 were sentenced to death and executed, 274 sentenced to various periods of transportation and penal servitude, 2170 to various periods of imprisonment, and 276 to be whipped, fined, or discharged on sureties. Of those not convicted, 35 were outlawed, 7 were found insane, 55 were found not guilty, and 179 not proven; the remainder were discharged without trial.

In 1857 was commenced a more complete report, under the title of Judicial Statistics. In this year the report was confined to criminal statistics, of which the following is an abstract.

Police and Constabulary.—The number and expense of the police and constabulary for every county and town, with their respective divisions, and the cost, are given. The total number in England is 19,187, consisting of 7801 for the various county constabularies, 5251 for borough police, 6083 for the metropolitan police, and 552 for the city of London police. The total cost of this force for the year ended Sep. 29, 1857, had been 1,265,579*l.*; of which 441,569*l.* was for the county constabulary, 337,853*l.* for the borough police, 442,212*l.* for the metropolitan police, and 43,945*l.* for the city of London police. A part of this expense, except in the case of the city of London, is defrayed from the public revenue, there being paid to the county constabulary 71,112*l.*, to the borough police 60,970*l.*, and to the metropolitan police 103,380*l.* In the year there were altogether 401,264 cases of minor offences, assaults, petty thefts, drunkenness, vagrancy, and offences under the Highway Acts, Licensed Victuallers and Beer Acts, Stage-carriage Acts, &c. Of these, 314,432 were by males, and 86,832 by females. Of the total, 369,233 cases were decided summarily by magistrates; 233,759 were convicted, and 135,474 were discharged. The remaining 32,081 cases were the results of 57,273 offences which had come to the knowledge of the police, and of these 17,861 were committed or bailed for trial. Of the total number apprehended by the police, the classification is as follows:—

	Males.	Females.	Total.
Known thieves	18,556	4,546	23,102
Prostitutes	..	24,282	24,282
Vagrants and tramps	14,272	4,998	19,270
Suspicious characters	40,112	6,692	46,804
No known occupations	5,218	1,696	6,914
Previous good characters	112,017	14,548	126,565
Characters unknown and not ascertained	124,257	30,070	154,327
	314,432	86,832	401,264

Of the convictions, the number for assaults was 44,860, for drunkenness 44,894, for theft 20,577, and for vagrancy 18,023.

Criminal Proceedings.—The total number of persons committed for trial in 1857 was 20,269, of whom 15,970 were males, and 4299 were females; of these, 15,342 were convicted: 1442 for offences against the person, 1752 for offences against property with violence, 10,850 for offences against property without violence, 101 for malicious offences against property, 830 for forgery and offences against the currency, and 332 for offences not included in the foregoing classes. There were 54 sentenced to death, of whom 20 were for murder, and of these 13 were executed; the punishment in all the other cases being commuted to transportation or penal imprisonment.

Prisons.—The report notices great improvements in the construction and management of prisons. The number of persons committed to them in 1857 was—

	Males.	Females.	Total.
For trial at assizes or sessions . .	15,958	4,254	20,212
On summary conviction	62,170	24,625	86,795
For want of sureties	2,318	845	3,163
On remand and discharged	10,631	4,022	14,653
For debt and on civil process . . .	13,499	840	14,339
Under the Mutiny Act	2,808	..	2,808
	107,384	34,536	141,970

Of re-committals for crimes or offences, there were 42,169, of which 18,374 had been previously committed once, 8128 twice, 4400 thrice, 2970 four times, 1857 five times, 2276 six and seven times, 1700 eight to ten times, and 2464 above ten times. Of the commitments, 1877 were of children under twelve years of age, 10,624 were between twelve and sixteen, and 29,949 were between sixteen and twenty-one. Omitting prisoners for debt, and the military, there were 124,823 persons in confinement, of these 97,054 were English, 2903 Welsh, 2399 Scotch, 18,067 Irish, 652 from British colonies and the East Indies, 2016 foreigners, and 1732 not ascertained. Of the whole, 44,291 could neither read nor write, 72,387 could read or read and write imperfectly, 6348 could read and write well, 409 had had a superior education, and

1388 were not ascertained. The amount of prison accommodation is stated to be sufficient on the average; but some of the prisons of populous places are occasionally over-crowded—such as Middlesex, Westminster, Wandsworth, Durham, &c. The daily average number of prisoners was about 19,686, and the total cost for the year was 567,804*l.*, but this includes 120,799*l.* expended on new buildings, alterations, and repayments, leaving 447,004*l.* as the ordinary annual charge for prisoners, an average of 23*l.* 10*s.* 3*d.* for each, divided thus:—for repairs, furniture, &c., 5*l.* 0*s.* 5*d.*; for officers' salaries, pensions, &c., 9*l.* 17*s.* 8*d.*; for prisoner's diet, clothing, medicine, &c., 8*l.* 12*s.* 2*d.*

The government prisons now provide for the treatment of convicts sentenced to long terms of detention, the great proportion of whom it had been the practice to transport to the penal colonies, or to confine on board the hulks. They are:—

"1. The Millbank prison, now chiefly used as a general receiving prison and depôt for convicts of both sexes, including a penal class for both, but appropriated also in part for a class of females undergoing the first stage of their punishment.

"2. The Pentonville prison, adapted for the preliminary period of separate confinement and instruction of adult male convicts.

"3. Portland prison, for able-bodied male convicts undergoing the second stage of their punishment, and employed upon the public works.

"4. Dartmoor prison, principally for infirm and sickly male convicts, who are employed in farm labour, and partly in manufacture.

"5. Portsmouth prison, and 6, Chatham prison, for able-bodied male convicts in the second stage of their punishment, who are employed in the heavy unskilled labour of the naval yards and arsenals.

"7. Brixton prison, exclusively for females in the second stage of their punishment, employed in needlework and the domestic labour of the prison.

"8. The hulk 'The Stirling Castle,' at Portsmouth, used chiefly as a receiving ship for prisoners sent from the convict establishments at Gibraltar and Bermuda for release in this country, and for a small number of invalid prisoners.

"9. Parkhurst, used as a reformatory for boys, who are employed in farm labour, and partly in manufacture.

"10. Fulham Refuge, for females under reformatory treatment in their second stage of discipline."

In these various prisons, there were at the commencement of 1857, male prisoners 6171, females 830, and 6236 males and 758 females were received during the year; of the whole, 1032, all males, were sent to Western Australia, Bermuda, and Gibraltar; 2871 males and 333 females were removed from one prison to another, including those removed from the abolished hulks, and removed to lunatic asylums; and 178 females were sent to reformatories; 162 males and 6 females were discharged on the termination of their sentences; 886 males and 86 females were discharged on tickets of leave; 9 males on commutation of sentence; 58 males and 15 females were pardoned; 68 males and 17 females died; 2 males committed suicide and 6 escaped; a total of 5675 disposed of, and 8320, of whom 7368 were males and 952 felmaes, remained in the beginning of 1858.

Crime in Ireland.—In 1857 the total number of persons committed or held to bail was 7210, of whom 3285 were not convicted. Of the number committed, 5458 were males and 1752 were females. Of the number convicted, 1036 were for offences against the person; 814 for offences against property committed with violence; 1641 for offences against property without violence; 61 for malicious offences against property; 57 for forgery and offences against the currency; and 1816 for other miscellaneous offences. Only 6 were sentenced to death; and none were executed; 40 were sentenced to transportation, 396 to penal servitude for various periods, 2674 to various terms of imprisonment, and the remainder whipped, fined, discharged on sureties, or pardoned. In the year there had been 23,563 summary convictions before magistrates or at petty sessions, and 9,557 committals for drunkenness.

Crime in Scotland.—In 1857 the total number of offenders committed for trial or bailed was 3840, of whom 2743 were males and 197 females. Of the whole, 920 were acquitted on trial, discharged without trial, or found insane. Of those convicted, 1140 were for offences against the person, 408 for offences against property committed with violence, 1903 for offences against property committed without violence, 53 for malicious offences against property, 89 for forgery and offences against the currency, and 207 for other offences not included in the foregoing classes. Of the total, 557 males and 316 females could neither read nor write; 1625 males and 697 females could read and write imperfectly; 467 males and 75 females could read and write well; and 82 males and 7 females had had a superior education; 14 are unaccounted for. Of the punishments, 3 were sentenced to death and executed for murder; 28 sentenced to various periods of transportation; 230 to various periods of penal servitude extending from three years to life; 460 to various periods of imprisonment from three years to more than six months; 1877 to imprisonment for six months and under; and 287 to be whipped, fined, and discharged.

In 1859 the plan was more completely carried out. We give the statement below of the crimes and punishments of 1858; but the returns of the Civil Procedure do not come within our limits, and we therefore confine ourselves to the criminal returns:

Police and Constabulary.—The number and expense of the police and constabulary for the whole of England and Wales, were 20,256 men (including the chief officers and other officials), and 1,447,019*l.* The borough constables, appointed by watch committees were 5804; the county constables, 7549; the metropolitan police constables, 6295; and the city of London constables, 608. The salaries and pay amounted to 1,081,748*l.*; allowances and contingent expenses, 41,824*l.*; clothing and accoutrements, 106,097*l.*; superannuation and gratuities, 55,886*l.*; horses, harness, forage, &c., 29,609*l.*; station-houses, charges, printing, &c., 108,896*l.*; other miscellaneous charges, 23,459*l.* The borough police cost 366,207*l.*, of which the treasury paid 70,528*l.*; the county constabulary cost 553,483*l.*, of which the treasury paid 99,774*l.*; the metropolitan police cost 480,736*l.*, of which the treasury paid 113,338*l.*; and the city of London police cost 46,593*l.*, the whole defrayed by the city.

The investigations of the police have ascertained more precisely than had ever been done before, the real numbers of the criminal classes. The report states that in 1858 there were:—

		Males.	Females.	Total.
Known thieves and depredators,	under 16	4,773	1,608	6,381
,,	over 16	26,772	6,879	33,651
Receivers of stolen goods,	under 16	119	29	148
,,	over 16	3,410	787	4,197
Prostitutes	under 16		1,647	1,647
,,	over 16		27,113	27,113
Suspected persons	under 16	3,912	1,512	5,424
,,	over 16	28,028	5,774	33,802
Vagrants and tramps	under 16	3,265	1,942	5,207
,,	over 16	11,390	5,962	17,352
		81,669	53,253	134,922

These are at large, and the numbers in prison on September 1858 were—in county and borough prisons, 15,774, of whom 11,742 were males, and 4032 females; 7628 in government convict prisons, of whom 6556 were males, and 1072 females; and 2022 in Reformatories, of whom, 1690 were males, and 332 females; making a total of 160,346 for the criminal classes. The distribution of criminal classes varies considerably; in the metropolis they form 1 in 187 of the population; in the pleasure-towns, such as Brighton, Bath, and others, they are 1 in 97; in towns depending upon agricultural districts, Ipswich, Reading, Lincoln, and others, they are 1 in 78; at the commercial ports, 1 in 93½; in the seats of the cotton and linen manufactures, 1 in 154½; in the seats of the woollen and worsted manufactures, 1 in 175½; in the seats of the small and mixed textile manufactures, Norwich, Macclesfield, Coventry, &c., 1 in 113; and in the seats of the hardware manufacture, 1 in 48. The agricultural districts vary less: it is 1 in 115 in the eastern; 1 in 104½ in the south and south-western, and 1 in 103½ in the midland. These numbers are so far satisfactory that, though large, they are not so large as have often been estimated. In 1801, for instance, Mr. Colquhoun ('Police of the Metropolis'), then stated the number of prostitutes at 50,000; a number much exceeding the whole number now in England and Wales. During the year, the police had information of 57,868 offences against the criminal laws; and 30,458 persons were apprehended, of whom 22,455 were males, and 8003 females; of the total, 11,789 were discharged, 191 discharged on bail, &c.; 1330 bailed to appear at trial, 82 committed for want of sureties; and 17,066 committed for trial. The number of persons tried was 17,855, of whom 4576 were acquitted or not prosecuted, and 33 were found to be insane. Of the convictions, 1393 were for offences against the person, of whom 38 were sentenced to death and 11 executed; 115 to various periods of penal servitude; 1166 to various periods of imprisonment with whipping, fines, &c.; and 74 to be whipped and discharged; for offences against property with violence, 1442 persons were convicted; of whom 15 were sentenced to death; 528 to various periods of penal servitude; 897 to various terms of imprisonment with whipping, &c.; and 2 to be whipped and discharged; for offences against property without violence, 9074 persons were convicted, of whom 1295 were sentenced to various terms of penal servitude; 759 to various terms of imprisonment, &c.; and 20 to be whipped and discharged; for malicious offences against property, 74 persons were convicted, of whom 40 were sentenced to various terms of penal servitude, and 30 to periods of imprisonment, &c.: for forgery and offences against the currency, 793 persons were convicted, of whom 131 were sentenced to periods of penal servitude, and 662 to various periods of imprisonment; for offences not included in the above classes, 470 persons were convicted, of whom 21 were sentenced to periods of penal servitude, 317 to various periods of imprisonment, &c.; and 132 to be whipped, fined, and discharged.

For minor offences the number of persons proceeded against summarily was 404,034, of whom 143,744 were discharged on examination by the justices, and 260,290 convicted, of whom 216,120 were males, and 44,170 females, of these, 65,261 suffered short periods of imprisonment, only 73 being above six months, and 20,968 being for fourteen days or less; 160,636 were fined; 10,360 were ordered to find sureties, 3781 were delivered over to the army or navy, 502 were whipped, and 19,750 otherwise punished. The offences for which convictions were obtained were, being drunk and disorderly, 51,861 persons, of whom 42,890 were males, and 8971 females; assaults of various kinds, 49,873 persons, of whom 40,893 were males, and 8980 females; trifling thefts and attempts to steal, 21,698, of whom 16,241 were males, and 5457 females; offenders under the Vagrant Act, 18,630, of whom 9798 were males, and 8832 females; for offences under the Police Act, the Hackney-carriage Act, local acts, Licensed Victuallers' and Beersellers' Acts, the game laws, and offences relating to servants, apprentices, &c. contribute the remainder. Of the total number of charges the report states that 54,149 were against suspicious characters, 153,576 of persons of previous good characters, 138,388 of persons whose characters were unknown, 17,683 against habitual drunkards, and 21,473 against habitual tramps.

Prisons.—In 1858 the total number of persons committed to them was 139,457, of whom 105,175 were males, and 34,282 females; a number not varying greatly from the average, but remarkable for the continued increase of commitments under the County Court Act, forming nearly 12 per cent. of the whole; but though these are punishments, being usually for what is termed contempt of court, that is, non-appearance or non payment of debt, they are scarcely to be considered criminal. There were committed for trial at assizes and sessions 18,904 persons, on summary convictions 83,128, for want of sureties 3678, on remand and discharged 12,519, for debt and on civil process 16,620, of whom 976 were women, and 4675 men, under the Mutiny Act, for desertion, &c. Of re-committals there were 41,580, of these 2131 males and 875 females had been committed above ten times, 754 males and 559 females had been committed from seven to ten times, and 13,574 males and 4694 females were committed for the first time. Of the total number 1553 were under 12 years of age, 8776 were between 12 and 16, the great mass were between 16 and 40, numbering 86,845; there were 12,088 between 40 and 50, 5297 between 50 and 60, only 2798 above 60, and 805 whose ages were not ascertained. Of the offenders 93,169 were English, 2867 Welsh, 2282 Scotch, 15,887 Irish, 567 colonial or East Indians, 1927 foreigners, and 1463 not known. Of the whole, 397 had received superior instruction, 6813 could read and write well, 68,227 could read and write imperfectly, 41,826 could neither read nor write, and 899 not ascertained. The total expense of prisons and prisoners for the year was 560,012*l.*, of which 151,267*l.* were for the maintenance of prisoners, the remainder of the nature of fixed charges for the buildings, management, &c. The whole sum gives an average cost for each prisoner of 29*l.* 16*s.* 8*d.*, apportioned thus:—for buildings and fittings, 11*l.* 11*s.* 8*d.*; officers and attendants, 10*l.* 3*s.* 11*d.*; prisoners diet, clothing, &c., 8*l.* 1*s.* 1*d.* The profits on the labour of prisoners had been 23,194*l.*, made up to 29,727*l.* by other small receipts, derived from prisoners; the local rates and funds produced 420,619*l.*, and 109,666*l.* were defrayed from the public revenue, the chief part as proportion of the charge on convicted prisoners. The convict prisons are now ten, the hulks have been altogether superseded, and transportation has in a great measure ceased. The number of convicts undergoing punishment at the commencement of the year was 7748, of whom 6795 were males and 953 females; during the year, 3171 males and 373 females were added, and 3410 males and 254 females were disposed of as follows:—1390 males were removed to Western Australia, Bermuda, and Gibraltar; 6 males sent to county gaols or reformatories, 12 males and 5 females transferred to lunatic asylums, 1557 males and 212 females discharged on termination of sentence, 303 males and 9 females with tickets of leave, 17 males and 4 females on commutation of sentence, 26 males and 10 females pardoned, 96 males and 14 females died, and 3 males escaped. At the end of the year there remained in the various prisons 6556 males and 1072 females. The cost of these convict prisons had been 262,473*l.*, the value of convict labour had been 7762*l.*, and the net yearly cost of each prisoner had been 31*l.* 14*s.* 10*d.* The criminal lunatics under confinement on Sept. 29, 1858, numbered 686; of whom 530 were males and 156 females. The total cost of police prosecutions in 1857, county and borough prisons, convict prisons, reformatories, and criminal lunatics, was 2,381,054*l.*, of which 1,590,850*l.* were defrayed from local funds, and 790,204*l.* by the government.

Crime in Ireland.—In 1858, the total number of persons committed or held to bail was 6308, a smaller number by 902 than in 1857. The convictions were 3350, there were 18 found insane, 1327 were found not guilty on trial, no bills were found against 971, no prosecutions were instituted against 492, and 150 were bailed and not tried. Of the committals, 4708 were males, and 1600 females. Of the number convicted, 895 were for offences against the person; 191 for offences against property, committed with violence; 1485 for offences against property, without violence; 31 for malicious offences against property; 25 for forgery and offences against the currency; and 723 for other offences not included in the foregoing classes, chiefly breaches of the peace. Of the convicted, 5 were sentenced to death for murder, and 4 were executed; 340 were sentenced to penal servitude for various periods; 2374 to various terms of imprisonment, 488 to be whipped, fined or discharged, and 140 of whom the sentence was respited, or who were pardoned. Of the convictions there were 1356 males, and 845 females, who could neither read nor write; 302 of both sexes were under sixteen, 1148 were under twenty-one, 2041 were between twenty-one and thirty, 1241 between thirty and sixty, 84 were above sixty, and of 1497 the age could not be ascertained. The number of prisoners in all the jails of Ireland was 2844 on January 1, 1859, a decrease of 421 from 1857. The total number of persons passing through prison in the year had been 33,999, of whom 28,501 were convicted either at assizes or quarter-sessions. At the sessions there were convicted and committed to prison 764 deserters, 1440 persons under the Vagrant Act, and 7873 for drunkenness, more than double the number committed in 1857.

Crime in Scotland.—In 1858 the total number of offenders committed for trial or held to bail was 3782, of whom 2718 were males, and 1064 females. Of these, 3167 were tried (615 having been discharged, found insane, or outlawed for non-appearance), and 2891 were convicted. Of the convictions, 1171 were for offences against the person, 440 for offences against property, committed with violence, 1734 for offences against property without violence, 93 for malicious offences against property, 91 for forgery and offences against the currency, and 253 for other miscellaneous offences. Of the total, 515 males and 294 females could neither read nor write, 1566 males and 670 females could read and write imperfectly, 529 males and 91 females could read and write well, and 80 males and 3 females had had a superior education. Of the punishments, none were sentenced to death, 289 were sentenced to penal servitude for various periods, the greater number for four years; 370 to imprisonment for periods between two years and more than six months, 1816 for various periods between six months and less than one month, 6 to be detained in reformatory schools, and 348 to be whipped, fined, or discharged on sureties. Of the number committed, 93 were under twelve, 315 between twelve and sixteen, and 52 were above sixty years of age. The number of prisoners in all the prisons of Scotland on December 31, 1858, was 2114 for criminal offences, and 72 on civil cases, of whom 1189 were males, and 997 females; the number of commitments in the year had been 17,922.

CRIMINAL CONVERSATION. [ADULTERY.]

CRIMINAL LAW. [LAW, CRIMINAL.]

CROCKET, an ornament of very frequent use in Gothic architecture. It consists of leaves, leafy buds, or flowers, growing out of the angular sides of pinnacles, spires, canopies, and the label moulding of windows and doors, and sometimes, though less frequently, in other places—the only exception to their occasional use in Gothic work of some period or place seeming to be upon horizontal features. Figures of animals occasionally occur as crockets. There are no examples of crockets in the Norman or round arched style. In the first pointed, or Early English style they are meagre, as in Lincoln cathedral, but afterwards they become fuller, and more natural in their imitation. The latest examples, however, are larger, and have not so much the appearance of nature.

CROCONIC ACID. [RHODIZONIC ACID.]

CROCUS OF ANTIMONY. [ANTIMONY, *compounds with sulphur.*]

CROCUS SATI'VUS—*Medical properties of.* The saffron crocus is a native of Asia Minor, but is extensively cultivated in the more southern countries of Europe. That which is obtained in England, chiefly from Suffolk, is from the *Crocus autumnalis*, and is scarcely now to be met with, being nearly supplanted by the saffron imported from Spain. The officinal part is the stigmata of the flower, with a small part of the style attached. The part of the style receives the name of föminelle, and the less of this there is, the finer is the saffron. The stigma consists of three narrow club-shaped, somewhat petaloid portions, about one or two inches in length, of a brown or orange-yellow colour, with an aromatic, pleasant, but somewhat stupifying odour, and bitterish aromatic taste. The plant flowers in September and October, and once a day (some say twice) the stigmata are carefully plucked out of the open flowers, and dried on paper or sieves, either in the sun, in a room, or by kilns, if the weather be unfavourable for drying in the sun. The attention necessary for procuring it in perfection may be estimated from the circumstance that nearly 40,000 flowers are required to yield one pound of saffron. The statement that 107,520 or still more 203,920 flowers are required is a gross exaggeration. The good saffron occurs only in the state called *hay;* that which is termed cake saffron is entirely composed of the flowers of a compound plant called *Carthamus tinctorius*, or safflower. Other sophistications are said to be practised, but they are of rare occurrence, except oiling old saffron, to give it the appearance of fresh. Portions of smoked flesh are easily detected by not yielding colour like saffron. The chemical analysis by chemists agrees as to constituents, but differs as to the respective quantities, a difference arising from the quality of the specimens examined.

	Vogel and Bouillon Legrange.	Aschoff.
Volatile oil	7·5	1·4
Wax	0·5	4·0
Polychroite	65·0	52·0
Gum	6·5	10·4
Soluble albumen	0·5	—
Woody fibre	10·0	19·0
Water	10·0	10·0
Balsamic matter, soluble in ether and alcohol	—	2·0
	100·0	98·3

The volatile oil is yellow, and heavier than water, and possesses a bitter, acrid, burning taste, and is partially soluble in water. By keeping it undergoes some change, for it becomes white, and is then lighter than water. To it is chiefly owing the medicinal properties of saffron, while the colour seems owing to the *polychroite*, which seems to be a combination of a volatile oil and a red bitter substance.

Saffron formerly enjoyed a high repute, both as a perfume, and as a nervine, stomachic, and narcotic drug. That the odour has powerfully affected some very susceptible individuals is undeniable; but so little regard is now paid to it, that it is employed chiefly as a colouring ingredient, or adjunct to other more powerful agents. It is still a popular remedy during the eruptive stage of exanthematous diseases, a remnant of the old doctrine of colours; and to the same notion is to be referred the practice of giving it to canary birds when moulting, a practice reprobated by Bechstein, who judiciously recommends iron to be put into the water at these times, such as a rusty nail. (Bechstein, On 'Cage Birds,' p. 223.)

The stigmata of the *Crocus vernus* have a colouring principle which is imparted very readily to alcohol, less so to water or oil. But as these can be procured at a much cheaper rate than those of *C. sativus*, they might be used where colour alone is required.

CROMLECH. Certain primeval remains, consisting of three or more rude stones set upright in the earth, and supporting one large horizontal stone so as to bear a general resemblance to a table, have long been known in this country as cromlechs. The first application of the name does not appear to be known, but if its meaning be as stated by Dr. Pughe, "an inclined or flat stone," it would seem to be merely a convenient popular designation. Worsaae and some recent antiquaries have extended the word so as to make it synonymous with the German Steingräber, and Hünengräber, stone graves and giants' graves; but here it will be used in its more confined and more usual sense.

Cromlechs are met with in various parts of England, Ireland, Scotland, and Wales, and the Channel Islands; in Brittany and other parts of France (where they are known as *Dolmen*); in Germany, Denmark, Spain, and elsewhere in Europe; in North and South America, and even in various parts of Hindustan (Capt. Meadows Taylor, 'Cromlechs, Cairns, and other Scytho-Druidic Remains in the principality of Sorapur;' and Hooker's 'Himalayan Journals,' ii. p. 320, &c.) They have consequently formed a fertile subject for the speculations of antiquaries and local historians. By many of our earlier antiquarian writers they were regarded as closely connected with the rites of Druidic worship—whence their common name of *druidical altars*. The top or cap-stone, or *bowing-stone* as it was sometimes called, was considered to have been placed in a horizontal position in order to receive the human victim; a slight inclination being given to the stone for the purpose of letting the blood run off. A single stone of large size occasionally found near the cromlech was supposed to have served as a pedestal for some deity. These opinions are pretty well exploded now. It is seen that the cap-stones have almost invariably the flat side turned downwards, and are indeed in all respects as unfitted for the reception of sacrificial victims as they well could be. On the other hand, wherever they have not been disturbed human remains are found in connection with them. Extended investigation has shown that among races in an early stage of civilisation it was a very widespread practice to protect the remains of a person of consequence with a massive stone covering. Cromlechs are now, in short, admitted by all archæological inquirers to have been places of sepulture. Originally, they were covered over with earth, and the circle of small stones by which they are still in many instances surrounded was probably the boundary of the enclosure, and defined the base of the tumulus. Much light has been thrown on the purport of cromlechs, and the modes of interment adopted in connection with them, by Mr. Lukis, who explored a large number of these monuments in Guernsey, which had fortunately been previously unopened. He found on removing the superincumbent earth and sand outside the inner chamber, or cromlech proper, not only human bones, but bones of the horse, the ox, and the boar; stones used for grinding and pounding, stone quoits, hammers, chisels, arrow-heads, &c., as well as rude pottery; and within the chamber, burnt human remains, and jars of various sizes containing limpet shells, &c., which he with great probability supposes were intended as food and offerings to the manes of the deceased. "The burnt human bones," he says, "appeared in distinct heaps, and the jars in contact had partaken of the colour of them. The very perfect calcination which had been adopted, made it difficult to conceive what kind of process had been used. Little or no charcoal was observed; the teeth were of a fine jet black; and the bones of the jaws grayish white; and, in some instances tinged with turquoise green colour." In the cromlech opened by him at L'Ancresse, in the northern part of Guernsey, Mr. Lukis found forty urns, varying from four to eighteen inches in height, but from the fragments of pottery remaining he arrived at the conclusion, that "not fewer than one hundred varieties of vessels must have been deposited from time to time during the primeval period." But he found in some cromlechs bodies interred which had not been subjected to cremation. Thus in one of the most extensive of the sepulchral chambers opened by him, called the Cromlech Du Tus, Mr. Lukis discovered on removing the cap-stone of the cromlech, two entire skeletons placed side by side in a kneeling position, the face of one being directed towards the north, and that of the other towards the south. ('Archæological Journal,' vol. i., and 'Journal of the Archæological Association.')

One of the largest of these remains in Great Britain is a double cromlech at Plas Newydd, Anglesey. [ANGLESEY, in GEOG. DIV.] The cap-stone of the larger of the two cromlechs is 12 feet long, 10 feet broad, and 4 feet thick, and is supported by four tall stones. There are, or were a few years back, no fewer than twenty-six other cromlechs in the Isle of Anglesey. One of the best known cromlechs in the southern part of England is that called Kit's Coty House, which stands near the road between Maidstone and Rochester, Kent. [AYLESFORD, in GEOG. DIV.] This, which resembles in character the Cromlech Du Tus, in which Mr. Lukis found the two kneeling skeletons, is formed by four upright stones, three of which standing on end and inclining slightly inwards, support the fourth, or cap-stone. This last is a huge block, 12 feet long, 9 feet wide, and 2 feet thick; while two of the upright stones are 8 feet high, 7 feet wide, and 2 feet thick. Another very noted cromlech consisting of several stones is that known as Wayland Smith's Cave, at Ashbury in Berkshire [BERKSHIRE, in GEOG. DIV.], but it is now in a very imperfect state, many of the stones having been broken and carried away for building a neighbouring barn.

CROPS. [EMBLEMENTS.]

CROPS, ROTATION OF. [ARABLE LAND.]

CROSIER, or CROZIER, from *Crocia*, in the Latin of the middle age, a pastoral staff or crook, formerly used by bishops and abbots. Several writers have supposed that it was derived from the *lituus*, or augural staff of the Romans: but they are mistaken. It was evidently copied from the well-known and common staff which shepherds, even to this day, make use of to catch hold of the hinder leg of their sheep in order to take them; and it has reference to the pastoral office of the bishops and clergy, according to the words of our Saviour, "I am the good shepherd," and to the common name of the clergy, pastors or shepherds.

These pastoral staffs were sometimes barely curled, and at others very richly ornamented; a few instances occur in which the upper part finishes in the form of a mace. The Sieur de Moteon, in his 'Voyages Liturgiques de France,' 8vo, Par. 1718, p. 272, says, many of the early crosiers were not curved. The abbot's staff was usually of a simpler form than that of the bishop. One of the earliest abbatical staffs, the form of which can be seen in England, is probably that represented on the tomb of abbot Vitalis, in the cloister of Westminster Abbey, who died in 1082. Some of the episcopal crosiers appear to have been among the most exquisite examples of the 13th and 14th century Italian goldsmiths' and enamel work; some of the French crosiers of the same date are also extremely rich and of admirable workmanship. (Labarte, Du Sommerard, De Caumont, Waring, &c.) The most splendid English episcopal crosier remaining is that of William of Wykeham, of silver gilt, richly enamelled, which is exhibited to visitors in the chapel of New College, Oxford, to the society of which the bishop himself bequeathed it in 1404. (See Lowth's 'Life of Wykeham,' 3rd edit. 8vo, Oxf. 1777, p. 263, where it is engraved.) Another very fine cross, beautifully ornamented with nielli, is that of Bishop Fox (died 1528), preserved at Corpus Christi College, Oxford. A crosier of oak was found on opening the tomb of Bishop Fox at Winchester. Crosiers of wood were in ancient times usually buried with bishops and abbots in their coffins. One, of red wood, the top carved into the rude form of a ram's head, was found many years ago, upon opening the coffin of bishop Grosteste at Lincoln, who died in 1253. It lay across the body from the right shoulder to the left foot. At the bottom of the neck of this staff, upon a brass plate, was this inscription: "Per baculi formam Prelati discito normam." (Gough, 'Sepulchr. Mon.' vol. i. p. 47.)

According to Labarte it is an error of modern writers to apply the term crosier "to the crook-shaped pastoral staff of a bishop; the crosier, strictly so called, is the cross on a staff borne by an archbishop." ('Arts of the Middle Ages,' p. 430, trans.) But whatever may be the "strict" use of the term in the Romish church, crosier is the received term among English archæologists for the episcopal crook. The crosier in the sense used by Labarte, or as we should say the cross, is employed by the Romish hierarchy as a mark of distinction. Thus the pope alone is entitled to have a cross with three transverse beams carried before him; cardinals and archbishops have the double cross; while bishops have a cross of the ordinary form, or with a single beam. (Didron, 'Iconographie Chrétienne.')

CROSS. Various religious edifices called crosses, from their being surmounted with this emblem of Christianity, have been erected in England and on the Continent. Of these, the most remarkable in England are the memorial crosses erected on the places where the body of Eleanor, queen of Edward I., rested each night on its way for interment in London. Three of these still remain, at Geddington, Northampton, and Waltham Cross, near London. The last, which is the most elegant, consists of four stories. It is hexagonal on the ground plan, and beautifully enriched; the story immediately above this is supported by buttresses, and formed into niches, in which are three figures of the queen. The core at the back of the figures is carried up beyond the niches, and has been restored with a battlement and a cross sustained on a crocketted spire. Market-crosses were formerly very common in England. They are often designed with niches and vaulted, thus forming an open chamber, as at Salisbury and Chichester. Other crosses of this kind remain at Malmsbury, Glastonbury, and elsewhere. Winchester Cross, which is one of the most perfect of the crosses erected for religious purposes, is of much later date than those erected in memory of Queen Eleanor. Near Ely, on the road to Downham Market, there is a singular cross, consisting of a long slender stone shaft, on the top of which there are richly carved niches projecting beyond the sides of the shaft. Pillar crosses were often erected in churchyards, as well as by the way-side or meeting of four roads; and many of these still remain, though usually in a mutilated condition. Perfect churchyard crosses, however, exist at Great Grimsby, Higham Ferrers, &c.

Churches are usually built in the form of a cross. [CHURCH.] The largest of these constructed crosses are those of St. Peter's at Rome and St. Paul's, London. In the Western Church, what is called the Latin cross has mostly been employed; whilst in the Eastern Church the Greek cross has been commonly used: the difference in the form being that, in the Greek cross the four arms are of equal length, while in the Latin the lower arm (the nave in churches) is longer than the rest. What is called the Maltese cross is merely the Greek cross with an ornamental expansion of the extremities of the arms. On the symbolism of the different forms of the crosses used in Roman Catholic ceremonials, and seen in pictures, sculptures, &c., see Didron, 'Iconographie Chrétienne.'

Churches and ecclesiastical buildings almost always had crosses fixed on their gable ends. These crosses varied considerably in form and style of ornament in the different periods of Gothic architecture; many of them are of great elegance; but crosses having being condemned as superstitious by the parliamentary visitors of the Commonwealth period, large numbers were destroyed or mutilated. A large cross, or crucifix, called a rood, was, prior to the Reformation, placed over the chancel in most parish churches, and in all cathedrals, upon a beam or gallery, called the rood-beam or rood-loft. The cross upon the altar was usually a crucifix; that is, had a figure of the Saviour represented hanging upon it. A cross was very commonly the principal figure carved upon monumental brasses [BRASSES], and indeed upon monuments generally.

By European navigators, the planting of a cross was used to indicate that possession was taken of the country for the nation by whom it had been discovered.

Crosses used for processional purposes were during the middle ages often made of great beauty and costliness. A very excellent specimen of a processional cross of the 14th century is engraved as a frontispiece to Paley's 'Gothic Architecture.'

In some of the Roman Catholic processions at Rome enormous crosses, constructed of wood and cardboard, are carried, balanced in a waistband round the body of a strong man.

CROSS, from the Latin 'Crux.' This cruel mode of punishment appears to have been in use from the earliest recorded periods of history. It was possibly the invention of some barbarous tribe to prevent the escape of a captive by fastening him to a tree, or used to inflict death on an enemy by leaving him to expire of want, or a prey to birds and beasts.

Crosses, whatever was the original form, were, in course of time, made of two pieces of wood. These crosses have been divided by antiquaries into three kinds. The crux decussata, or cross divided like the letter X, and usually called St. Andrew's cross; the crux commissa, or joined cross, consisting of an upright piece of timber with a transverse piece on the extreme top at right angles with the first, like the letter T; and the crux immissa, or let-in cross, in which the transverse piece of timber is let into the upright, but placed somewhat below the top of the upright in this form ✝. This is the cross on which Christ is usually represented to have suffered, and though there may not be any absolute authority for ascertaining the precise form of the cross used on that occasion, yet apart from the fact of the early Christian writers having without exception referred only to this form, the circumstance of an inscription having been placed over his head would render the conjecture probable.

Amongst the Carthaginians, persons of all conditions, even commanders of armies, were subjected to it, but amongst the Romans it was considered as the punishment of slaves, and inflicted on that class only. With respect to the Jews, it seems doubtful whether crucifixion, as we understand it, was a mode of punishment used by them in ancient times. The putting the sons of Saul to death by the Gibeonites has been adduced as furnishing evidence that crucifixion was practised by them (2 Sam. xxi.); but the practice does not seem to warrant the conclusion. It is however to be observed that "hanging on a tree" is used in Scripture to describe crucifixion. (Acts x. 38.)

Previous to crucifixion the sufferer was scourged. He was also forced to carry his own cross; and this (amongst the Romans at least) probably arose from the disgust and horror with which this instrument of punishment was viewed and considered by that people, and their disinclination even to touch it. (Cicero 'in Verrem.') The criminal was accordingly condemned to bear his own instrument of torture. Previous to the infliction of the punishment, the sufferer was stripped naked, and it is probable that he was laid down on the cross for the purpose of having the nails driven in his hands and feet, or being fastened with ropes, which was sometimes the case. The cross was then elevated. Afterwards the legs were broken, wounds inflicted with a spear, or other sharp instrument, to hasten death, but this was not invariably done. As death, in many cases, did not ensue for a length of time, guards were placed to prevent the relatives or friends from giving the sufferers relief, taking them away whilst alive, or removing their bodies when dead. The punishment of the cross was abolished in the Roman empire by Constantine, who substituted hanging.

The representations of crucifixions by painters are calculated to give very erroneous notions both of the cross itself and the mode of punishment. It is not probable that the crosses actually used were so lofty or so large and massive as those which we see in pictures. Instruments of such dimensions would be perfectly unnecessary for the purpose. When we read in Josephus of hundreds of Jews being crucified by Vespasian and Titus in a day, we cannot suppose that so great a quantity of timber would be used on those occasions. The circumstance of the sufferer carrying his own cross weighs against the probability of its being of the size which these representations give it. It is not unusual in paintings to represent crucifixion as taking place after the cross is elevated, and the executioner is represented standing on a high ladder, and driving a nail into the hand of the crucified person. It seems much more likely that the sufferer was nailed to the cross before it was raised and fixed in the ground. "Pone crucem servo," "Put the cross to the slave," is the expression used by Juvenal. Crucifixion sometimes took place with the head downwards, and St. Peter is said to have suffered death in this way.

Death by the cross, in a strong and healthy person, must necessarily have been tedious and lingering, and instances have occurred of persons who, after remaining some time on the cross, were taken down, and survived. When the crucified person was only attached to the cross by ropes, this seems by no means extraordinary; and even when it took place by nailing, neither the wounds themselves nor the quantity of blood lost would be sufficient in all cases to bring on speedy death. During the reign of Louis XV. several women (religious enthusiasts, called Convulsionnaires) voluntarily underwent crucifixion. Dr. Merand, an eye-witness at some of the meetings of these persons, relates that he was present at the crucifixion of two females, named Sister Rachel and Sister Felicité. They were laid down, fixed by nails five inches long driven firmly through both hands and feet into the wood of which the crosses were made. The crosses were then raised to a vertical position. In this manner they remained nailed, while other ceremonies of these fanatics proceeded. Sister Rachel, who had been first crucified, was then taken down: she lost very little blood. Sister Felicité was afterwards taken from her cross. Three small basins, called palettes, full of blood, flowed from her hands and feet. Their wounds were then dressed, and the meeting was terminated. Sister Felicité declared that it was the twenty-first time she had undergone crucifixion.

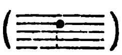
CROSS BILL. [PLEADING.]

CROSS BOW. [ARCHERY.]

CROSS REMAINDER. [REMAINDER.]

CROTALUM (*κρόταλον*), an ancient musical instrument, which, as appears from medals, was used by the Corybantes, or priests of Cybele. The crotalum differed from the sistrum, though the names are often confounded, and is by some supposed to have been of the castanet kind. ('Dict. de Trevoux.') Some consider it as a cymbal of small dimensions; and from the allusions to it by Virgil, Lucretius, and others, we are inclined to be of the latter opinion.

CROTCHET, in music, a character or note formed of a round head, and a stem descending from the left side of the upper part—



It is the fourth part of a semibreve, and in slow time (*largo*, for instance) its duration is about one second.

CROTON OIL. The seeds of the *Croton Tiglii* were formerly used as a drastive purgative medicine, under the name of grains of Tilly, or Molucca grains, or purging nuts, a term which occasionally leads to confounding them with physic nuts, the produce of the *Jatropha Curcas*; but at present the oil only is employed. The seeds are roasted, and then subjected to compression; the oil is therefore termed an expressed oil. It is of a honey-yellow or brownish colour, of moderate consistence, having an odour resembling the resin of jalap; the taste is at first slightly rancid, afterwards acrid, causing a feeling of burning in the throat, which lasts for several hours.

A portion of the oil is taken up by alcohol, and more by ether; it is however soluble in every proportion in fixed and volatile oils. It was supposed to contain a peculiar principle termed Tiglin; but this is now known to be a magnesian soap. It is often adulterated with olive or castor oil, which admixtures may be detected by the process suggested by Dr. Nimmo. An artificially prepared substitute, sometimes met with, is a mixture of the resin of jalap, Canada balsam, fixed oil, euphorbium, &c. (Horst.) The oil of the seeds of *Jatropha Curcas* (Linn.) is also sometimes mixed with the genuine oil. In the dose of one drop (when the pure oil is used) it produces considerable purgative effect, and may be very advantageously employed when difficulty of swallowing exists, since its application to the tongue is often sufficient to ensure the purgative action. Hence in cases of apoplexy, or paralysis of the throat, the desired effect may be obtained even when the patient is insensible. In the treatment of that form of inflammation of the brain termed hydrocephalus, even when effusion appears to have taken place, and torpor or paralysis exists, croton oil will often bring about the recovery of the sufferer. (See Abercombie on 'Diseases of the Brain, 1st edit., p. 157.) In cases of impending apoplexy croton oil is of incalculable value. It is likewise used, but sometimes very improperly, in cases of obstruction of the intestinal canal. It is however useful in aiding in the expulsion of the tape-worm, when proper anthelmintic medicines have been prescribed. The powerful impression which it makes on the intestinal canal renders it useful in some cases of dropsy. It is in most instances proper to combine it with castor oil, almond emulsion, or an alkali, to lessen its acrimony.

The seeds are employed in India, "and are used in the form of pills, commonly called *Jamalgota pills*. The natives usually separate the embryo, and combine the albumen of the seed with catechu or pepper." (Royle.) Where the embryo is not extracted before using, even one seed has proved fatal. As the embryo seems to possess the greatest acrimony and purgative power in the *Jatropha Curcas*, this is removed by the inhabitants (Europeans) of the East Indies, and one seed may then be eaten with comparative safety; but a seed not so treated is then offered to an inexperienced person, and, if eaten, followed in many instances by serious consequences,—a very *mauvaise plaisanterie*.

The oil diluted with five parts of olive oil, or seven of oil of turpentine, is occasionally employed as a liniment to bring out a pustular or vesicular eruption, and to act also as a rubefacient; but this also requires caution.

CROTONIC ACID. An unimportant oleaginous acid obtained from *croton oil*. Its vapour is irritating to the eyes, and the acid itself is poisonous. Its composition is unknown.

CROTONINE. A doubtful alkaloid, said to be found in the seeds of the *croton tiglium*.

CROUP, a specific inflammation of the air tubes, giving rise to a peculiar secretion, which concretes almost immediately it is formed, producing a false membrane, which lines the affected parts. It has been shown [CATARRH] that the mucous membrane which lines the air passages is subject to two different kinds of inflammation, each presenting distinctive characters. In one the inflammation produces a secretion which does not concrete, constituting all the varietes of bronchitis, catarrh, &c. In the other the inflammation produces a secretion which consolidates almost the moment it is formed, giving rise to the various phenomena which constitute the peculiar disease denominated croup.

That the inflammation which terminates in the formation of the secretion peculiar to croup is of a specific nature, is argued, first, because it uniformly terminates in the production of this peculiar secretion; and, secondly, because this secretion is obviously not dependent on the intensity of the inflammatory action, since the phenomena characteristic of inflammation are often less acute in croup than in catarrh. It has been conjectured that catarrh depends upon inflammation of the secreting follicles of the mucous membrane, and that croup depends upon inflammation of the capillary arteries of its tissue, a conjecture which is probably correct, though in the present state of our knowledge it must be regarded merely as a conjecture. As the inflammation, however, presents in the essential phenomena characters so different, it is convenient to distinguish the one from the other by distinct names, and accordingly the former is termed catarrhal, and the latter plastic inflammation.

The false membrane, the result of plastic or croupal inflammation, moulds itself to the part inflamed; it does not extend beyond the inflamed portion of the mucous membrane; it varies in thickness from half a line to a line; it is of a white or whity-brown colour; it has the consistence of boiled white of egg, and its firmness is always greatest where it is thickest. When it is raised from the mucous membrane, the latter is always found to be reddened and swollen, but rarely to the degree common in catarrh.

This morbid secretion is most commonly poured out on that portion of the windpipe which constitutes the larynx; hence in general the larynx forms the peculiar and proper seat of croup; but the site of this adventitious membrane is by no means confined to the larynx; it often extends above to the glottis and epiglottis, and below to the bronchial tubes. When, as happens in the great majority of cases, the adventitious membrane is confined to the larynx and epiglottis, it presents the characters just described; but when it extends into the bronchial tubes it becomes modified in its appearance. It is then generally "formed into a single cylinder, but occasionally into a series of tubes inclosed within each other in the closest contact, and forming altogether a solid body, of a thick and tolerably firm structure, and in the exact form of the tube from whence it has been abstracted. Upon making a transverse section of this polypiform substance, concentric laminæ are very apparent. It adheres but slightly to the mucous surface, and may easily after death be drawn out entire, presenting a complete mould of a large bronchial tube, with all its subdivisions, down to its minutest ramifications"

Though in the croup the deposition of the adventitious membrane is commonly confined to the larynx, yet other parts of the mucous membrane in the immediate neighbourhood of the larynx are sometimes the seat of plastic inflammation, terminating in the formation of a precisely analogous morbid secretion. Occasionally "small yellowish-grey spots appear upon the fauces, surrounded by the mucous membrane, highly and darkly reddened. These spots enlarge, coalesce, and form a continuous false membrane, of the colour and consistence of the buffy coat of the blood, lining the throat more or less completely. Sometimes it is seen to cover the posterior half of the tongue, so that its anterior part might be elevated by a probe in a membranous form; occasionally, though not often, it passes down the œsophagus even into the stomach, but much more frequently it extends into the lung, producing all the symptoms of croup. When plastic inflammation is seated in the fauces, it gives rise to a disease called Cynanche Maligna, or gangrenous sore throat, so named from the supposition that the spots on the fauces consist of gangrenous sloughs; but more careful observation has demonstrated that they consist of an adventitious membrane. Nevertheless, gangrene does occasionally, though very rarely, co-exist with the deposition of a fictitious membrane, that is, the false membrane is deposited over a gangrenous surface." [DIPTHERIA.]

The most striking and characteristic symptoms of croup of course depend on the consequences that result from the obstruction to the free passage of the air to the lungs, that is, impeded respiration and change of the voice. The respiration is impeded in proportion to the quantity of adventitious membrane that is formed, and the consequent degree in which the calibre of the air-tube is diminished; in proportion to which must of course be the diminution in the column of air admitted to the lung. The air-passage in the progress of the disease is often obstructed to such a degree as to produce a most painful feeling of suffocation, attended with all the signs that denote the imminent danger of suffocation, and death is constantly occasioned by the narrowing of the air-tube to such an extent as actually to produce suffocation. In milder cases, when not impeded to this extreme degree, the respiration is still always difficult, anxious, and distressing. The edges of the circumference of the inferior extremity of the adventitious deposit being loose, mucous, and soft, frequently adhere to each other, so as to close up the tube, and require a strong effort of inspiration to overcome the temporary obstruction. "I have seen," says Dr. Davies, "a slight film of pseudo-membrane traversing the upper part of the larynx suffocate an infant almost instantly. The dyspnœa becomes always great when the concretion separates, and if it be not quickly expectorated, often destroys the patient immediately."

Owing to the diseased condition of the air-tubes, the acts of respiration and of coughing produce peculiar sounds. The inspiration is sonorous and ringing, as if the sound were formed and resounded in a brazen tube. Sometimes it is dry and hissing, resembling the sound produced by a piston forced through a dry pump, or by a crowing noise similar to that emitted by a chicken in the pip. The croupal cough is a peculiar, loud, clangous, ringing sound, which has caused it to be almost universally compared to the crowing of a cock. The voice partakes of the same character, being shrill and hoarse.

The fever excited in the system by this local inflammation is commonly acute and intense. The skin is burning hot; the face flushed, sometimes covered with perspiration; the eyes prominent, injected, or watery; the carotid arteries throb powerfully; the jugular veins are tumid, and the pulse at the wrist is frequent, hard, and wiry. Sometimes, on the contrary, the febrile symptoms are of a low or asthenic character; the skin cool, and of a dirty pallid colour; the pulse frequent, but exceedingly feeble; the breath fœtid, and the general prostration extreme.

As the disease advances, the restlessness and anxiety of the patient increase; the hand is constantly applied to the throat, which is often slightly tumified externally, and sometimes painful to the touch; the respiration becomes more and more difficult, the cough convulsive and exhausting, the countenance bloated, and the cheeks and lips either livid or exceedingly pale. In this stage the pulse becomes small, weak, and irregular, the eyes sunk, the skin cold and clammy, the voice lost, or capable only of a whisper; the head is constantly tossed back; the throat often seized as if to remove an obstacle to respiration; violent efforts are made to expand the lungs, and death at length puts an end to a state of intense suffering, either by convulsive suffocation, or by the subsidence of the restlessness and violence into a state of profound lethargy and stupor.

Croup, as has been stated, is almost peculiar to infants. It may occur at any period from the second month after birth to puberty; and the younger a child is, after it is weaned, the more liable it is to the disease. It is most apt to occur in the sanguineous temperament and the full habit. It often seizes a child not perfectly recovered from a previous illness, and is liable to a recurrence at distant intervals on exposure to causes which ordinarily produce only common catarrh. Yet it occasionally occurs in the adult, generally as a consequence of its extension from the fauces to the larynx. It is chiefly prevalent in the neighbourhood of large bodies of water, running or stagnant, salt or fresh, and especially among the ragged and half-starved children of the poor, who live on the sea-coast, or near the banks of rivers or canals. But it also occasionally prevails in other situations as an epidemic, especially during the continuance of north or easterly winds, after heavy and long-continued falls of rain.

There is perhaps no disease to which the human body is subject the progress of which is so frightfully rapid. In a few hours after the attack, the morbid secretion is often formed to such an extent, as to prove inevitably mortal; yet the inflammation of which it is the result might have been checked by immediate, vigorous, and judicious treatment. It is therefore of the last importance that those who have the care of infants and young children should be familiar with the first signs of the approach of this dreadful malady. Of these a graphic description has been given by Dr. Cheyne, who had abundant experience of the disease in situations in which it is but too prevalent. After having pointed out the importance of attending to the first appearance of hoarseness, which in very young children does not usually attend common catarrh, and consequently, when observed in a child living in a district which generates croup, this symptom is always much more deserving of attention, especially if accompanied with a rough cough, than it would be after puberty, this excellent physician says,—

"In the approach of an attack of croup, which almost always takes place in the evening probably of a day during which the child has been exposed to the weather, and often after catarrhal symptoms have existed for several days, he may be observed to be excited; in variable spirits; more ready than usual to laugh or to cry; a little flushed, occasionally coughing; the sound of the cough being rough, like that which attends the catarrhal stage of the measles. More generally however the patient has been for some time in bed and asleep before the nature of the disease with which he is threatened is apparent; then, perhaps without awaking, he gives a very unusual cough, well known to any one who has witnessed an attack of the croup; it rings as if the child had coughed through a brazen trumpet; it is truly a *tussis clangosa;* it penetrates the walls and floor of the apartment, and startles the experienced mother—'Oh, I am afraid our child is taking the croup!' She runs to the nursery, finds her child sleeping softly, and hopes she may be mistaken. But remaining to tend him, before long the ringing cough, a single cough, is repeated again and again: the patient is roused, and then a new symptom is remarked; the sound of his voice is changed; puling, and as if the throat were swelled, it corresponds with the cough: the cough is succeeded by a sonorous inspiration, not unlike the kink in pertussis—a crowing noise, not so shrill, but similar to the sound emitted by a chicken in the pip (which in some parts of Scotland is called the roup, hence probably the word croup); the breathing, hitherto inaudible and natural, now becomes audible, and a little slower than common, as if the breath were forced through a narrow tube; and this is more remarkable as the disease advances. A blush of inflammation may sometimes be detected on the fauces, and in some rare instances a slight degree of swelling round the larnyx, and the child complains of uneasiness in his throat, and says he is choking. The ringing cough, followed by crowing inspiration, the breathing as if the air were drawn into the lungs by a piston, the flushed face, the tearful and blood-shot eye; quick, hard, and incompressible pulse; hot dry skin; thirst, and high-coloured urine—form a combination of symptoms which indicate the complete establishment of the disease. Sometimes the symptoms enumerated subside about midnight, even in the absence of medical treatment; perhaps to return in the course of the following evening. From seven or eight o'clock till midnight this complaint is always at its height; but in general, unless the patient be treated with promptitude and judgment, the disease may be expected to terminate fatally; a new order of symptoms, the second stage of croup, as it is called, taking place in the course of the next day."

If the diet of the child be changed from its ordinary food to that of the simplest and blandest kind, as gruel or arrow-root, the moment the hoarse cough and rough voice are perceived; if it be immediately placed and kept in bed in an equable and moderately warm temperature, and one grain or two grains of the powder of ipecacuanha be given every hour, or every alternate hour, all the symptoms may subside without any further remedies, and the threatened attack be effectually prevented; but if with this hoarse cough and rough voice the child be allowed its ordinary diet, and be exposed as usual to the open air, the attack will hasten on in the mode described until the disease is fully established; and then any treatment that may be employed, to be of the least avail, must be most energetic. The prompt employment of the most powerful remedies is indispensable; yet they must be administered with cautious and judicious boldness. It is a disease in which the inflammation, which it is the great object of medical treatment to subdue, is not so much of a violent as of a peculiar character, and this renders it necessary that the practitioner should be guarded in the administration of some of the more powerful remedies to which he must resort, and especially in the employment of blood-letting. When the fever is intense, the skin hot, the pulse full and hard, and the patient plethoric, bleeding must indeed be employed, and carried as far as the strength will admit; but experience has amply shown that in this disease the strength will not admit of its being carried as far as is safe and even necessary in diseases purely inflammatory. Bleeding, either by the lancet or by leeches, which latter should never be applied to the throat itself, but to its immediate neighbourhood, is a most powerful auxiliary; but it is not *the* remedy to be relied on. *That* is mercury, which should be given instantly and efficiently, that is, in doses of from one to three grains of calomel every hour, or every two hours, until the mouth be affected, the breath fœtid, or the patient relieved. If the calomel irritate the bowels, the *hydrargyrum cum creta* may be substituted, or a free inunction of the mercurial ointment, which latter may be conjoined with the calomel, or the mercury and chalk powder. Many practitioners prefer the full employment of tartar emetic to the mercurial plan of treatment. All agree that blisters are useful auxiliaries, applied at the bottom of the sternum, or between the shoulders, but never at the throat. The vomiting produced by the tartar emetic sometimes powerfully promotes the expulsion of the adventitious membrane. There are other remedies of minor importance, the judicious employment of which may assist in putting a stop to the progress of this most formidable malady. The use or abuse of these cannot be discussed here; but what has been stated may excite the attention of the mother, and guide her to the choice of efficient remedies in the first hour or two of the attack, during which it may not be always possible to obtain medical aid.

(Dr. Cheyne *on Croup;* Dr. T. Davies *on the Diseases of the Lungs and Heart, in loco.;* Gœlis, *Tract. de Rite Cognoscenda et Sananda Angina Membranacea;* Copland, *Dict. of Pract. Med.;* and *Cyclop. Pract. Med. in loc.*)

CROWN, the ornament of the head which denotes imperial or royal dignity, from the Latin *corona.* The radiated appears to be the earliest form of the royal crown with which we are acquainted. It appears upon the heads of the figures which are represented upon the Persian darics: radiated crowns also occur on the coins of Antiochus IV. of Syria, and of his successors; on many of those of the Greek cities; and on those of Augustus and other emperors down to the very destruction of the Roman empire. The fillet, and the laurel wreath, were also used as crowns in very remote times: the fillet was the most universal of all. In Constantine's time the fillet of pearls came into use; which the latter Byzantine emperors turned into a kind of coronet. Focas, as he is called upon his coins (not Phocas), has a plain low crown. Later emperors varied its form according to their fancy. Manuel Palæologus, who was crowned in 1363, is represented wearing a close crown studded with pearls. (See Du Cange, 'Hist. Byzant.,' p. 242.) The trefoil upon the crown is thought to be of Gothic introduction. We find it on the crowns of Clovis and his sons, which has induced antiquaries to call it the fleur-de-lis (Montfaucon, 'Monum. de la Mon. Fr.,' p. xxviii. Diss. prelim.), but the truth is, these trefoils were used on Constantinopolitan crowns before the time of the Franks (Ibid., p. xxxii.), and afterwards on those of German princes no way allied to Charlemagne. (See Montf. i., xxxiii.)

Crowns were placed on the statues and images of the heathen gods, as well as worn by the priests in sacrificing. Some antiquaries have even thought that the crown was originally rather a religious than a civil ornament; and that it only became common to kings, inasmuch as the ancient kings were priests as well as princes.

In regard to the crown as used in our own country, a fillet diadem of pearls appears on several of the Saxon sceattæ; upon one or two others a radiated diadem occurs. (See Ruding's 'Annals of the Coinage of Britain,' pl. 6, 7.) Similar diadems or fillets adorn the heads of many of the Heptarchic kings, and continue as the most common crown upon our coins through the whole of the Saxon series. The circle surmounted by three small projections first occurs upon the coins of Athelstan; on some of Edred's coins the projections end in pearls. A radiated cap appears first on a coin of Ethelred II., and the trefoil ornament upon the crown upon a few of the coins of Canute. Several varieties of arched cap and crown appear upon the coins of Edward the Confessor. (See Ruding's plates, 15–23.) The close or arched crown, which appears on some of Edward the Confessor's coins, is used on all the types of Harold, and was adopted by the earlier Norman kings. On Edward the Confessor's and the Conqueror's coins, we see labels appended at each ear; these, as we learn from an anecdote related by William of Malmsbury, in wearing the actual crown, were fastened by a clasp or button beneath the chin. On the coins of Stephen and Henry II., the open crown with fleurs-de-lis appears. Henry III. wears on his seals a crown fleury, pointed or rayed, the points raised, but not high, between the flowers; in his second seal the points are wanting, as on that on his tomb; but in Matthew Paris we read he was first crowned with a circle of gold. Edward I. has a similar crown on his coins and seals to that of Henry III. as well as his queen upon her tomb; so have his successors Edward III., Richard II., Henry IV. and V. Evelyn ('Numism.,' p. 34) says the monarchs of England were the first who pretended to the arched crown: that is, as it appears in modern times. Selden ('Titles of Honour,' edit. 1762, b. i. chap. 8) says he had read that Henry V. was the first of them that had a crown of the kind. In a window of Ockholt House in Berkshire, built by John Norreys, Esq., in 1465, there certainly remained, till within a very few years, the arms of Henry VI. and his queen Margaret of Anjou, in separate coats, both surmounted by the arch barred crown; from Henry VII. downward, this arched crown, with the globe and cross, has been continued.

Two of the most celebrated mediæval crowns are that of Charlemagne, preserved in the Imperial treasury, Vienna, and the iron crown of the Lombards, used at the coronation of the kings of Italy, and which is kept in the cathedral of Monza. The crown of Charlemagne "is composed of eight plates of gold, four large and four small, connected by hinges. The large ones, studded with precious stones, form the front (the central one being surmounted with a cross), the back, and the intermediate points of the crown; the small ones placed alternately with these, are ornamented with enamels, representing Solomon; David; King Hezekiah seated on his throne, having before him the prophet Isaiah; and Christ seated between two flaming seraphim, such as the Greeks usually represent them. The costume of the figures resembles that of the emperors of the lower empire, and although the inscriptions which accompany the figures are in Latin, the whole bears the impress of Greek workmanship. The ground of the figures is formed by the metal itself, which has been hollowed out to receive the enamel; but all the details of the design are traced out with fine fillets or gold by the process already described. The flesh tints are in rose-coloured enamel; the colours employed in the draperies and accessories are deep and light blue, red and white." (Labarte, 'Arts of the Middle Ages.') The iron crown of Lombardy owes its name to a ring of iron incrusted in the interior, which is reputed to have been formed from a nail of the true cross. "It is composed of a kind of collar of gold of about from 2¾ to 3 inches wide, and loaded with sapphires, rubies, emeralds, and other precious stones uncut, interspersed with flowers of gold. Apart from its antiquity, it possesses no other merit than the richness of the materials of which it is formed, and does not manifest any great artistic talent in the Lombard or Italian goldsmiths of the 6th century." (Labarte.) This crown gives its name to a famous order of knighthood, the crosses of which have, up to the present time (1859), been distributed by the Emperor of Austria. In France Louis XII. wore a single bar arched over his crown, about 1500; before, only a cap, till he married Henry VIII.'s sister. Till Francis I. an open flowery border, somewhat like our ducal coronet, was generally used. In Spain, Philip II., after he married Queen Mary, used a barred crown. In Germany, Maximilian, grandfather of Charles V., first wore an arch over a ducal coronet. In Denmark, Christian III, after he came into England, used the barred crown. James IV., on his marriage with Margaret, daughter of Henry VII., introduced it into Scotland. John Duke of Braganza was the first who used it in Portugal.

Among the Romans there were various kinds of crowns distributed as rewards for military and other achievements. The principal were the Civic, presented to a soldier who had saved the life of a citizen; the Mural, awarded to the soldier who first scaled the walls of a besieged city; the Obsidional, presented by the garrison of a beleaguered city to the commander who relieved them; the Naval or Rostral crown, given to the commander who won a naval victory; the Triumphal, worn by the general during his triumph; the Olive, conferred upon soldiers and officers by whose services a triumph had been obtained.

CROWN SOLICITOR. In state prosecutions in England the solicitor to the treasury acts as solicitor for the crown in preparing the prosecution. In Ireland there are officers called crown solicitors attached to each circuit, whose duty it is to get up every case for the crown in criminal prosecutions. They are paid by salaries. There is no such system in England, where prosecutions are conducted by solicitors appointed by the parish or other persons bound over to prosecute by the magistrates on each committal; but in Scotland the still better plan exists of a crown prosecutor in every county, who prepares every criminal prosecution whatever.

CRUCIBLE, a chemical vessel in which substances are exposed to high temperatures. Crucibles are made of various materials, forms, and sizes, and are often called *melting pots.* Earthen crucibles are used for the purpose of assaying ores, as those of lead, copper, and tin. For these purposes the refractory kind, called Hessian or Cornish crucibles, are prepared; they cannot however be employed for heating saline, alkaline, or earthy matters, as these would act upon them. Sometimes they are made of commoner and more fusible clays, when not required to withstand a high temperature. Crucibles made of porcelain are occasionally used, but they are extremely apt to crack.

Black-lead crucibles, formed of about three parts of finely-powdered plumbago, and one of good clay, are also much employed, especially in melting metals; they are more expensive than earthen crucibles, but are less liable to crack.

Glass-makers' crucibles are usually made of Stourbridge clay.

In fusing the alkalies, potash and soda, silver crucibles are used; but as they readily melt, or at least become very porous, they are not much employed for other purposes.

For chemical uses, platinum crucibles are principally employed; they withstand a high temperature, and are not in general easily acted upon. The alkalies however, and the alkaline nitrates, and the alkaline earths, act upon them; and those metals which readily fuse, such as bismuth, lead, and tin, immediately destroy them when heated in them. Care must also be taken not to expose platinum crucibles to the direct action of fuel, otherwise they become brittle and useless. They should be placed inside a common Hessian crucible, with a layer of magnesia inserted between the two crucibles. If gas be used as fuel, this precaution is unnecessary.

CRUSADES. Under this name are designated the religious wars carried on for two centuries between the Christians and Mohammedans at a time when diplomatic negotiations were unknown, and the sword decided all matters in dispute between one nation and another. The cause was ultimately lost by the Christians, who sacrificed in the struggle the lives of several millions of their brethren, though their claim was originally a reasonable one. In the beginning the Christians demanded only a free pilgrimage to the holy sepulchre, but afterwards the contest was for the possession of Jerusalem. The crusades however were by no means wars of conquest or of royal caprice; man fought against man for some higher yet mistaken principle. Hence their struggle offers something more honourable than the generality of wars, and deserves particular attention on account of its influence upon the civilisation of Europe.

As long as the caliphs of Bagdad and after them the Fatemides of Egypt possessed Palestine, the Christians were not checked in the exercise of the religious practice of visiting the holy sepulchre, which was in harmony with the opinions of that age: the Caliph Harun-al-Rashid had even the keys of the holy sepulchre forwarded to Charlemagne as a present. But when the Turks had effected the conquest of Palestine, the hospitality of the Arabs gave way to the brutality of the new possessors; the Christians were subjected to so many vexations, that the whole of Europe re-echoed with the complaints of the pilgrims; who instead of returning to their homes loaded with holy relics, brought back only wonderful tales of their insults and sufferings.

In consequence of this, Pope Sylvester II. (who died in 1003) began to preach a crusade against the Seljuk Turks for the conquest of the Holy Sepulchre. Sixty years afterwards, when only 2000 pilgrims had returned to Germany out of 7000, who had been sent to Palestine by their bishops, and the possession of Jerusalem had fallen into the hands of the Turkish chief Ortok, this untoward event filled Europe with consternation, and a desire to revenge the wrongs of the pilgrims. A single spark only was wanting to inflame the whole of the western empire to a contest with the sword for that privilege which Harun-al-Rashid had acknowledged.

Thirty years however elapsed before Pope Urban II. decreed the first crusade. First at the council of Piacenza (March, 1095), afterwards at that of Clermont in Auvergne (November, 1095), supported by the ambassador of the Emperor of Constantinople and numerous powerful lords, he proclaimed the sacred war, and appointed the 15th of August (1096), the Day of Assumption, for the departure of the army. The minds of the Christian warriors had been previously excited by the preaching of Peter of Amiens (the Hermit), and by the loud complaints of the patriarch of Jerusalem, who, provided with letters of credit from the pope, travelled through Europe, and filled all classes of society with enthusiasm for this holy warfare. Those who determined to set out for the Holy Land wore on their breast the figure of a red cross, and hence the name of Crusaders.

First Crusade.—The departure of the army having been deferred for a year, Peter of Amiens, Walter Habenichts, Count Emiko of Leiningen, and the priest Gottschalk, impatient of delay, and prompted by religious fanaticism, set out with an immense multitude, which is stated at 80,000 or 100,000 men, besides women and children, and a crowd of followers. This army, after having ill-treated and robbed the Jews in their own country, was reduced to one-third of its number in Hungary; the remainder was cut to pieces at Nicæa, in Asia Minor.

The east was now threatened with a national migration from the west. The bulk of the army was twice as numerous as that of their forerunners. It was headed by the noblest knights of those times,—Godefroy of Bouillon, duke of Lower Lorraine; Baldwin his brother; Hugo the Great, brother of the king of France; Robert, duke of Normandy, son of William the Conqueror; Raymond of St. Gilles, duke of Toulouse; and Bohemond, prince of Tarentum. The general indulgence proclaimed at Clermont, the feudal system, which led the vassals to join in the sentiments of their sovereigns, combined with the religious fanaticism of the many and the interested views of the few, created this formidable army. The pope had the address to dispose the heads of the Crusaders to acknowledge him formally as the sovereign of all the lands which they intended to conquer. The results of this expedition were of great importance. After crossing the sea into Asia, the Crusaders took possession of Nicæa in Asia Minor, and Laodicæa and Antiochia in Syria. Bohemond obtained the principality of Antiochia; Baldwin that of Edessa. New Christian principalities arose also in Tripolis, Sidon, Tyre, and other places. In the mean time Jerusalem was no longer in possession of the Turks. The Caliph Mostaali had taken it from the successors of Ortok (1096), and had again united it to Egypt, making a rival caliphat. [FATEMIDES.]

The Crusaders, however, did not allow themselves to be stopped in their victorious march by this change of circumstances: they advanced with 60,000 men, the relics of their army, against Jerusalem, besieged the town, took it (1099—June 7, July 15), and preserved it, together with all their conquests, in the great battle of Ascalon, against the Caliph of Egypt and the Seljuk chieftains. It is said that the number of slain in the conquered town amounted to 70,000. The Jews were burnt in their synagogues.

Consequences of the First Crusade. Kingdom of Jerusalem.—Godefroy of Bouillon was elected king of Jerusalem—a new state, with a considerable territory. The constitution of this new kingdom was regulated by a statute called "Les Assizes de Jerusalem." Godefroy died one year after his accession to the throne; his brother Baldwin was his successor, who was followed by Baldwin II. (1118), Fulk (1131), Baldwin III. (1148), Almerich (1162), Baldwin IV. (1173), Baldwin V. (1186), who was followed by Guido of Lusignano, who reigned till 1187, when Saladin put an end to the Christian kingdom. These kings of Jerusalem were compelled to fight with a force of only about 12,000 regular troops against the power of two mighty enemies, the Turks and the Fatemide caliph of Egypt.

Crusaders' Religious Military Orders.—The first Crusade brought two military religious orders into existence—the Knights of Jerusalem, instituted by Baldwin I., and the Knights Templars, established by the joint efforts of Hugo de Payens, Godefroy of St. Adhemar, and seven other knights. The German Knights of the Cross are of later origin.

Second Crusade.—Though the Franks had extended their possessions from the mountains of Armenia to the very boundaries of Egypt, their strength was too feeble to prevent (under the government of Baldwin III., 1144) the Atabek of Mosul from taking Edessa. The Atabeks were governors of the dynasty of the Seljuks. One of the Atabeks, named Emad-eddin Zenghi, from Mosul, having made himself independent, transmitted the kingdom to his son, Nureddin the Great, who fixed his residence in Aleppo, and became an object of terror both to the Christians and to the Fatemides. In the mean time the kingdom of Egypt had passed into the hands of Selaheddin (Saladin the Great), an event which took place under the following circumstances: In order to settle a contention about the succession, Nureddin sent a Kurd, named Shirkuh, into Egypt. The peace-maker usurped the government for himself, and bequeathed it to his brother Ayub's son, who after the death of the last of the Fatemides seated himself on the throne of these rival caliphs, and conquered Egypt, nominally for the caliphat of Bagdad. This son of Ayub was called Saladin; and the dynasty of which he became the founder is in history known by the name of the Ayubides. After Nureddin's death, Saladin conquered almost all Asia Minor, in addition to Tripolis and Tunis, and destroyed the Christian kingdom of Jerusalem.

After the conquest of Edessa, Bernard of Clairvaux took upon himself the office of Peter the Hermit, and preached a second crusade, in consequence of which two of the greatest Christian chiefs, the German emperor Conrad III., and Louis VII., king of France, were induced to take the cross (1147). For this undertaking Western Europe armed 140,000 knights and near a million of foot soldiers, and yet in spite of their mighty force the expedition failed. The changes which had taken place in the East had raised up a new enemy against the Crusaders in the emperors of Constantinople, who were less afraid of the peaceful governments of the Turks in Asia Minor and Egypt, than of the depredation and ravage which the passage of a disorderly army, such as that of the Crusaders, would cause to their possessions. Hence the artifice and treachery of the Emperor Manuel Comnenus prepared the way for the destruction of the Christian armies. The German emperor, misled by treacherous scouts, lost in the defiles of Taurus the bravest of his soldiers; the relics of his army were almost destroyed at the siege of the fortress of Iconium. The troops of the French were also defeated by the Sultan of Room, and annihilated before Damascus, a town which the Christians had in vain attempted to take by storm. The relics of the two armies united in one body (1149). Thus the expedition of the Crusaders in the East was a complete failure. The only successful result of this undertaking was the retaking of Lisbon from the Moors, which was effected by the Christian navy.

Situation of the East after the Second Crusade.—Baldwin III., however, did not give up his plans in despair. His army was at intervals increased by small bodies of Crusaders, who came to his assistance from Europe. Nureddin the Great felt more than once the power of the Christian warriors. Yet all these advantages were frustrated by the discord of the Crusaders, fomented by the rivalship of the Templars and the Knights of Jerusalem. Baldwin was succeeded by Almeric, called also Amauri, who was followed by Baldwin IV., who died likewise soon after the battle of Ramla. After his death Guido of Lusignano was completely defeated at the battle of Tiberias; he was taken prisoner, together with the grand master of the Templars, and many noble knights (1187). Saladin took possession of all the important places in Palestine, together with Jerusalem and its environs, and put an end to the Christian kingdom of Jerusalem, which had existed a century. But Saladin showed himself a generous conqueror; he granted to the Christians the possession of the Sepulchre of Christ, and allowed the prisoners to return home. The patriarch Heraclius, the clergy, the knights, and many soldiers returned to their homes, or withdrew to the few towns which the Christians still possessed on the coast of Palestine.

Third Crusade.—Bishop William of Tyre brought this bad news to Rome, which it is said caused the premature death of Pope Urban IV. The youth of Europe were again summoned to appear under the banner of the cross, not to defend the right of visiting the Holy Sepulchre, for Saladin had already granted this privilege to the Christians; but the lives of the bravest knights of Europe were to be thrown away on the insane project of again conquering the kingdom of Jerusalem. Europe obeyed the summons. The German emperor, Frederick Barbarossa, Philip Augustus, king of France, and Richard Cœur de Lion, king of England, and several German princes, enlisted themselves as Crusaders. The Italians appeared in arms under the bishops of Ravenna and Pisa. The Knights Templars, and those of Jerusalem, who were scattered about Europe, collected themselves again in strong bodies, and sailed for the Holy Land. Fifty vessels left the harbours of Denmark and Friesland, and thirty-seven those of Flanders, for Palestine. The expenses of the war were supplied by a tithe, called Saladin's tithe, which the pope ordered all Christians, including even the clergy, to pay. The Emperor Frederick I., a man of ability and experience, had found means to compel the Emperor of Constantinople to favour the undertaking. He was also engaged in negotiations with the Sultan of Iconium, who however betrayed him. By these means, and with a force of 600,000 armed men, this expedition might have succeeded; but the Crusaders did not carry on their military operations in one body. Several troops of Italian, Greek, and German adventurers, who advanced before the great army to place themselves under Conrad of Montferrat, lord of Tyre, and Guido of Lusignano, made an unsuccessful attempt to take Ptolemaïs (St. Jean d'Acre). Frederick I. met with a premature death by bathing in the waters of the river Cydnus, 1190. His son, Frederick of Swabia, who died soon after, put himself at the head of the relics of the imperial army, but was not able to give a favourable turn to the siege of Acre. At length Philip Augustus and Richard Cœur de Lion appeared on the battle-field. Richard had already taken and sold to Guido of Lusignano the island of Cyprus. The kings joined their armies before Ptolemaïs, and their united forces at last succeeded in taking this single fortress, after three years' siege and nine battles.

In consequence of these long and sanguinary struggles, the Christian army was so reduced, that the kings, despairing of success, thought of returning to Europe. Philip Augustus left Palestine soon after the capture of Ptolemaïs. Richard Cœur de Lion followed him after a short struggle with Saladin, with whom he made truce, and left him in possession of Jerusalem (1192). In the mean time Philip Augustus had made an inroad into Richard's dominions of Normandy. The mild, benevolent, and generous Saladin the Great died 1195, in Damascus, in his fifty-seventh year. During this crusade there arose a new military order, called the German Cross Knights, whose first grand master was Henry Walpode.

Situation of the East after the Third Crusade.—Conrad of Tyre had married the sister of Baldwin II., and thus acquired a claim upon the throne of Jerusalem. Guido of Lusignano, however, had already assumed this title. Conrad died by the hand of assassins. His widow afterwards married Guido's brother, and the two brothers assumed the title of kings of Jerusalem. One of them, named Almeric, died likewise, and the imaginary crown of Jerusalem was the inheritance of John of Brienne, the husband of the daughter of Conrad king of Tyre (1210).

Fourth Crusade.—Isaac Angelos, the Emperor of Greece, was robbed of his throne and deprived of his eyes by his own brother (1194). His son Alexius fled to Venice to ask for assistance (1203). In the mean time the enthusiast Fulk of Neuilly and Pope Innocent III. had prepared for a new crusade, which was headed by several Italian and French noblemen, such as Thiebauld of Champagne, Count Boniface of Montferrat, Count Baldwin of Flanders, and Simon of Montfort. The Doge of Venice, Arrigo Dandolo, induced the crusaders to take the town of Zara in Dalmatia for the republic of Venice. The Crusaders, probably at the instigation of Dandolo, instead of waging war against the infidels, took an active part in the affairs of Greece, conquered Constantinople, and after having elevated to the throne or deposed several emperors, at length put the imperial crown upon the head of Baldwin of Flanders, giving him the fourth part of the empire, and dividing the rest among themselves.

This behaviour drew upon them the popish interdict, which, however, was of no long duration: Pope Innocent absolved them. Thus the chief of the Franks ruled for about fifty years over the empire of the East, around which arose three new Greek principalities, Nicæa, Trebizond, and the despotat of Ætolia. This crusade was a complete failure.

Situation of the East after the Fourth Crusade.—After the insignificant crusade of Andrew, king of Hungary (1217), John, king of Jerusalem, led his army against Egypt (a plan which was certainly calculated to ensure the conquest of the Holy Land), and took Damietta. The sultan, Melek Kamel, fearing the consequences of a war, proposed peace and an exchange of Jerusalem for Damietta. The proud conqueror refused the offer, and proceeded without caution along the Nile towards Cairo. The sultan ordered the dikes of the Nile to be opened; the waters destroyed a large part of the Christian army, freed Damietta, and secured cessation from war for eight years, and the retreat of the relics of the Crusaders (1221).

Fifth Crusade.—Frederick II. of Hohenstauffen, the greatest of the German emperors, the husband of Yolanta the daughter of John of Jerusalem, had pledged himself at his coronation (1215) to a crusade. The affairs of the state, however, retarded for twelve years the fulfilment of his promises. At length, yielding to the pressing invitations of Pope Gregory IX., he sailed from Brindisi for Palestine. But after a few days' voyage, sickness compelled him to return to Otranto. This drew upon him the anger of the pontiff, who laid him under an interdict. Perhaps this was but a plausible pretext for humiliating the hated house of Hohenstauffen. Though under the pope's interdict, the emperor again appeared next year in arms in the Holy Land, which gave the pope an opportunity of allowing his enemies to invade the emperor's Italian dominions. Even John of Jerusalem was faithless and audacious enough to occupy by force the kingdom of Naples.

The sultan, Melek Kamel, set no great value upon the possession of Jerusalem, and was willing to exchange it for an alliance with Frederick against his enemy the Sultan of Damascus. Frederick, pressed by his Italian affairs, profited by the good intentions of the sultan, and obtained from him the posession of the capital of Palestine. After putting upon his head the crown, he marched homewards with his army, and his approach to the Vatican was enough to determine the pope to take away the interdict.

Situation of the East after the Fifth Crusade.—The Khowarzm-shah Turks, pressed by the Mongols, who soon after put an end to the Caliphat, rushed into the Holy Land, and defeated near Gaza the whole of the Christian forces (1244). Jerusalem, together with Palestine, became a possession of the sultan of Egypt, as a member of their alliance.

Sixth Crusade.—Louis IX., king of France, called St. Louis, undertook in the year 1249 a new crusade. He followed the plan adopted by John of Jerusalem, and conducted his army against Egypt.

This land, however, seems to have offered few advantages to the Christian conquerors. Louis, after having easily obtained possession of Damietta, marched along the Nile towards Cairo, but, chiefly through the imprudence of his brother d'Artois, he lost the battle of Mansura, and with it the bulk of his army. D'Artois and many of the bravest knights were slain; hunger and sickness compelled the remainder to retreat. Before they were able to reach Damietta, they saw themselves overtaken and surrounded by the sultan, who made the king prisoner, together with the relics of his army. A truce was agreed on, in which the Christians were compelled to give up Damietta, and to pay a ransom of 800,000 Byzantine guilders. The Mamluks, a guard composed of Turkoman youth, who had gradually increased in power, dissatisfied with the generosity of the sultan towards the Christians, murdered him, and placed Ibek, their commander, upon the throne of the caliphs of Egypt. Louis, however, after some hesitation, was allowed to obtain his liberty.

Though Louis, upon his return to France, found his kingdom in a disordered state, on account of the misery and waste caused by the revolutionary movements of bands of a fanatic peasantry called Pastorells, he could not give up the idea of reconquering Jerusalem, and a few years after his return he prepared a new crusade. This crusade, however, did not extend beyond Tunis, where Louis expected to make converts of the princes. This undertaking failed likewise; and Louis found his grave on the shores of Africa (1270).

Seventh Crusade.—England was the pioneer of the seventh and last crusade. While Louis was still in Tunis, Edward, the grandchild of Richard Cœur de Lion, prepared a new crusade. After the death of Louis he appeared before Tunis, but soon left Africa for Palestine to fight against the Saracens. Not being able to accomplish his plans he returned home, and was the last among the Christian princes who dreamed of conquering the Holy Land.

Situation of the East after the last Crusade.—A few towns situated on or near the coast, Antioch, Ptolemaïs, and Tripolis, were still in possession of the Christians, and were chiefly defended by the Templars and other military orders. The dispute about the kingdom of Jerusalem still continued between the descendants of the Baldwins. At length Ptolemaïs fell (1291); the other towns were either abandoned or taken; the knights fled to Europe, and the whole of Palestine and Syria again became a possession of the sultans of Egypt, and obeyed the laws of Mohammed. In short, the labour of two centuries was lost; and we may regard this epoch as a kind of oriental restoration.

Crusades in the Western Empire.—We have already observed how Emiko of Leiningen and the priest Gottschalk had persecuted the Jews in the Rhenish provinces in their expedition towards the East. This was called a crusade against the Jews. The banner of the cross was likewise displayed in the wars against the Moors in Spain, against the heathens in Prussia and Lithuania, against the Waldenses and Albigenses in France, against all kinds of heretics, even against the house of Hohenstauffen, when placed under the popish interdict; which wars, unjust in their principle, were rendered by fanaticism still more terrible in their consequences.

Object of the Eastern Crusades.—The object of the first crusades was to obtain possession of the Holy Sepulchre for the Christians in Europe; and secondly, to protect the Christians in the East against the persecutions of the Turks. The first object might perhaps have been obtained by treaties: the second, however, could not be secured as long as the Turks possessed Palestine; and hence the conquest of this country became the principal object of the crusaders. This conquest might have been made in favour of the lawful lords of Palestine, the caliphs, but the Franks, misled by fanaticism, preferred to take for themselves that which by right belonged to others, and by a just retribution lost the fruits of two hundred years' struggle. On the other hand, if they had been guided by moderation, they might have easily obtained from the caliph Mostaali the possession of Jerusalem by treaties.

The object of the second crusade was from the very beginning inconsiderate. The possession of Jerusalem was not in danger; nothing had happened to cause a war, except the taking of Edessa.

The third crusade was undertaken with the view of reconquering the Holy Land. This war may appear just to those who think that the acquisition by the sword and the possession of a few years make a good title; or even to those who, misled by diplomatic sophistry, fancy that crowns and men may be inherited like goods and chattels. The crusade of Count Baldwin was an infamous intrigue and mystification of the Doge Arrigo Dandolo: the crusade of the king of Jerusalem was an idle attempt to change his imaginary crown into a real one by taking the towns of Egypt; neither of these expeditions deserves the name of crusade, a name that might be given with more propriety to the fourth crusade undertaken by Andrew, king of Hungary.

The hatred of the pope against the house of Hohenstauffen was the cause of the fifth crusade. In spite of the impure motives of this war, however, the emperor, by his prudent conduct, succeeded in obtaining the possession of Jerusalem without the sacrifice of time or blood.

The sixth and seventh crusades were undertaken with the object of regaining possession of Palestine, which had been lost in the battle of Gaza. The chief reason why so many powerful expeditions turned out signal failures may be sought in the rivalry of the knights of the same country, and the jealousy of their respective kings; hence there was no unity of action, no discipline, no commander-in-chief, and their numerous armies were scattered and defeated like sheep without a shepherd.

Consequences of the Crusades.—Though the crusades sacrificed the lives of several millions of Christians, among whom were many women and children, and though they were one of the causes which contributed to give the popes such an overwhelming power in Europe, although they were instrumental in bringing about the religious wars or persecutions which afflicted Europe, and also in weakening the power of the eastern princes, and rendering them unable to withstand the attacks of the Mongols, it cannot be denied that the crusades were accompanied by many beneficial effects.

Such, for instance, were the increased activity of political life in Europe, the union of different nations in a common object, the consequent dissipation of international strifes and prejudices, and a tendency to a more humane reciprocal intercourse, the acquisition of scientific knowledge, improvement in manners and habits, the breaking up of the feudal system by the sale of estates to the merchants in exchange for the money required by the nobles for their military accoutrements and provisions, the increased wealth of the mercantile towns in Italy, which led to the revival of the fine arts and the sciences in that country, and finally, the diffusion of more liberal modes of thinking in matters of government and religion, occasioned by the intercourse of the western and eastern nations. The great influence of the crusades in extending commerce has been pointed out by Heeren in his 'Essay on the Influence of the Crusades.'

Before the crusades the heavy clouds of religious fanaticism hung over Europe, and mankind bore quietly the chains imposed upon their minds by the authority of the priesthood. But the knight and the soldier who returned from the crusades, after having a thousand times experienced the generosity and hospitality of the Musselmans, brought home the singular tale that in those remote countries there existed a race of men noble-minded and kind, though professing a creed different from that of their invaders.

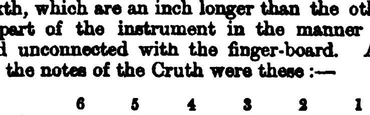
Blind submission to the authority of the priesthood was exchanged for meditation and independent reflection. The inquisition, which was instituted about this time, proves that there were men who were deemed fit subjects for an inquisition, that is, heretics and philosophers. One or two centuries after the crusades, Europe was filled with religious sceptics, as far as regarded the infallibility of the church, some of whom even dared to be religious reformers, such as Huss, Wycliffe, and others. At length Luther appeared, who by his theses and his translation of the Bible shook the very pillars of the Vatican.

Since the reformation of Luther, the Christian religion has been split into numerous sects, an event which some regard as injurious to religion. But as, in the chemical process of fermentation, in order to prepare a new and better product, it is necessary that the old matter be dissolved into minute particles (that the grape, for instance, be pounded and reduced to an unsightly juice, in order to make a pure and costly wine), so it is perhaps necessary that Christianity should be divided into many sects in order to clean it from all accidental impurities, and to make it fit to become the universal religion of mankind.

(Wilken, *Geschichte der Kreuzzüge*, Leipzig, 1807; Voltaire, *Histoire des Croisades*; Michaud, *Histoire des Croisades*; Robert Mons, *Historia Hierosolomitana*; Gibbon's *Decline and Fall of the Roman Empire*; Mill's *History of the Crusades*; Sybel, *Geschichte der erste Kreuzzüge*, 1841; and lastly, Michaud, *Bibliographie des Croisades*, which gives an account of all the writers who have treated this subject.)

CRUSCA, ACADEMIA DELLA. [ACADEMY.]

CRUTH, or CRWTH, a musical instrument of the violin kind, formerly much used in Wales. Sir John Hawkins says that "it somewhat resembles a violin, twenty-two inches in length and an inch and a half in thickness. It has six strings, supported by a bridge, and is played on by a bow. . . . . . The bridge is not placed at right angles to the sides of this instrument, but in an oblique direction, and one of the feet passes through one of the sound holes, and rests on the inside of the back." The four first strings are placed as in the violin, but the fifth and sixth, which are an inch longer than the others, are fixed to the upper part of the instrument in the manner of the arch-lute [LUTE], and unconnected with the finger-board. According to the same writer the notes of the Cruth were these:—



from which we are led to suppose that the strings were struck in pairs—two at a time.

The word Cruth was corrupted in pronunciation into *crowd;* hence a performer on the instrument was called a crowder. Butler, in 'Hudibras,' names his fiddler *Crowdero.* (Hawkins' 'Hist.' vol. ii.)

CRUX, a southern constellation formed out of Halley's observations, by Augustin Royer, in his maps, published in 1679. It is situated close to the hinder legs and under the body of Centaurus.

The following are the principal stars in this constellation:—

Character.	No. in Catalogue of British Association.	Magnitude.
δ	4120	3
ε	4158	4
α^2	4187	1
γ	4215	2
β	4289	2

CRY'OPHORUS, from the Greek words *κρύος* (cold) and the root of *φέρω* (to bear), is an instrument which was invented by Dr. Wollaston for the purpose of exhibiting the congelation of water in consequence of evaporation.

It consists of a glass tube about nine inches long, bent near the two extremities, and terminating with hollow balls of the same material. One of these balls is about half full of distilled water, which being made to boil, the air is expelled, the tube together with the other ball becoming filled with aqueous vapour: in this state the tube is hermetically sealed. The expansive force of the vapour, by producing a pressure on the surface of the water, prevents any further evaporation from thence; but, on plunging the ball containing no water into a mixture of snow and salt, the vapour in the balls and tube is suddenly condensed and a vacuum is produced, when an evaporation immediately takes place from the water, and the latter, in two or three minutes, is converted into ice.

CRYPT, a vaulted chamber, chiefly or entirely under ground. The term crypt is now almost exclusively applied to the vaults under churches and cathedrals; but as originally used, in reference to Roman buildings, it had a much more extended application, being employed for any low, narrow, underground vault. Thus, what would now be termed a tunnel, the carceres of a circus [CIRCUS], and even cloacæ [CLOACUS], were called *Cryptæ* (from *κρυπτειν, to conceal*). From forbidden rites or forms of worship being frequently performed in these underground chambers, they came to be commonly designated cryptic in reproach. The rites of Priapus were so spoken of; so also was the worship of the early Christians, who were accustomed to meet together in the catacombs of Rome [CATACOMBS] during the age of persecution. An arcade or portico enclosed at the side by a wall for protection from the sun and rain was called a *Crypto-Porticus.*

The crypts constructed under the older churches and cathedrals were intended to serve as chapels, and for the performance of certain rites and services,—no doubt in commemoration of the fact of the practice of the early Christian Church in its time of suffering. They have also in many instances been used as places of sepulture, or receptacles of the monuments of the dead, as at the abbey of St. Denis. In the crypts of several English churches human bones are found piled up with great regularity, and without any more than a vague and often manifestly unfounded tradition of the date at which they were placed there. Instances of this kind occur at Hereford Cathedral, Ripon Minster, Hythe Church, Kent, Christchurch, Hampshire, &c.

The vaulting in Norman, or Romanesque, and Gothic crypts is commonly supported on low massive columns and the basement walls of the church. Usually the crypt occupies but a part of the area of the church, usually the choir or chancel, but sometimes, as at Christchurch, one or both of the transepts. One of the largest and finest crypts in England is that under Canterbury Cathedral. [CHURCH.] In most of our cathedrals, and more important collegiate and parish churches, which have been rebuilt or enlarged at different times, the crypt is the oldest part of the structure. During the Norman period great attention was paid to the formation and enrichment of the crypt for the purposes of worship; but gradually it came to be regarded as of less and less importance, and no new ones appear to have been constructed after about the middle of the 13th century. One of the latest of these subterranean churches in England, the finest of its time, is that under Rochester Cathedral, which, with the choir, was rebuilt at the beginning of the 13th century. Several of the French and German Gothic churches have very fine crypts.

CRYPTIDINE ($C_{22}H_{11}N$). An organic base found in coal tar.

CRYSTALLINE. [ANILINE.]

CRYSTALLISATION. When a liquid is about to assume the solid state, and by the gentle application of heat or by its slow withdrawal the particles are drawn very gradually under the influence of cohesion [ATTRACTION], they do not form a confused amorphous mass, but in many cases arrange themselves into geometrical solids of great beauty and symmetry. Thus, if a mass of sulphur or of bismuth be melted, and allowed to cool slowly, so as to form a crust over the surface, if this crust be pierced and the liquid portion poured out, the cavity will be studded, in the case of bismuth, with beautiful cubic forms, and in the case of sulphur, with six-sided prisms and needles. These forms are called crystals, and the process is termed crystallisation. For the forms of crystals, see CRYSTALLOGRAPHY, in NAT. HIST. DIV.

CUBE (*κύβος*), a solid figure contained by six equal squares; a box of equal length, breadth, and depth.

Owing to its being the most simple of solids, the cube is the measuring unit of solid content, as the square is that of superficial content, or area. Whatever the unit of length may be, the unit of solidity is the cube which is a unit every way: thus we have the cubic inch, the cubic foot, &c.

Cubes of different sides are to one another as the algebraical third powers of the number of units in their sides: thus cubes which are as 7 to 10 in their sides are as $7 \times 7 \times 7$ to $10 \times 10 \times 10$ in their contents. Hence the algebraical third powers are called cubes; thus $a \times a \times a$ is called the *cube* of a. If the side of a cube contain a units, the content is $a \times a \times a$ cubical units of the same kind.

The cube has no *remarkable* properties, for our eyes are so used to the figure, that its properties seem self-evident.

Its internal diagonals are found by multiplying the number of units in the side by $\sqrt{3}$, or (very nearly) by adding one half and one half of one half, and subtracting one per cent. of the result, and if still further accuracy be required, 5 for every 10,000 units:—

```
2)10000 subtract 5 presently.
2) 5000
   2500
  ─────
  17500
    175
  ─────
  17325
      5
  ─────
  17320 feet in the diagonal
```

which is about six inches too small.

For the celebrated historical problem connected with this article, see DUPLICATION OF THE CUBE.

CUBEBENE ($C_{30}H_{24}$). An oily body isomeric with oil of cubebs, from which it is obtained by distillation with concentrated sulphuric acid.

CUBEBIN ($C_{34}H_{16}O_{10}$?). A non-azotised principle found in cubebs. It crystallises in groups of small needles, which are colourless and tasteless. It is only slightly soluble in cold water, alcohol, or ether, but is much more soluble in boiling alcohol. Concentrated sulphuric acid strikes a red colour with cubebin.

CUBIT, a measure of length in use among the ancients, and more especially among the Jews. The Hebrews called it אמה (*amma*), as the mother of other measures; the Greeks Πῆχυς (*péchus*); the Romans *Cubitus*, a word apparently formed from the verb "cubo," to bend for the purpose of lying down. The cubit was originally the distance from the joint or bending of the elbow to the extremity of the middle finger.

The best authorities assert that there were two cubits in use among the Hebrews; one sacred, the other common. In Deuteronomy, chap. iii. v. 11, the bed of Og is said to be nine cubits long and four broad, *after the cubit of a man.* The common cubit was eighteen inches; the sacred or great cubit (Ezek. xli. 8; and xliii. 5) of twenty-one inches, is stated to be a cubit and a hand-breadth. Calmet, however, is persuaded, that from the Exodus to the Babylonish captivity, there was but one cubit in use among the Hebrews, and then it was the Egyptian cubit. He says it is only *after* the captivity that Scripture notices two sorts of measures, to distinguish the old Hebrew cubit from that of Babylon, which the captives used during their abode in that city. On this, he adds, is grounded the precaution of Ezekiel, in observing that the cubit he is speaking of is the true old cubit, larger by a hand's breadth than the common cubit. There is no means of positively ascertaining the precise length of the cubit; the common cubit is stated to be 1 foot 9·888 inches, and a hand-breadth 3·684, in the table of Scripture measures inserted in some editions of the authorised versions of the Bible. This of course is Ezekiel's cubit. Among the Greeks the cubit (*péchus*) was twenty-four fingers (*δάκτυλοι*), measured as already explained. See Herodotus, ii. 175. (Arbuthnot, 'Tables of Coins, Weights,' &c.; and Calmet's 'Dict. of the Holy Bible,' in voce.)

CUCKING STOOL, a machine formerly used for the punishment of scolding women, consisting of a stool or chair attached to the end of a long pole, mounted in such a manner that the chair, with the offender placed in it, might be swung over a pond, and immersed as often as might be necessary. Several notices of the use of this apparatus, which was also called a *trebuchet*, a *tumbrel*, or a *ducking-stool*, are given in Brand's 'Popular Antiquities.' It appears to have been used as early as the era of the Saxon government in England, and to have been a common punishment, in some places at least, as late as the time of Gay, who mentions it in his 'Pastorals.'

CUCUMBER, a trailing annual, whose unripe fruit is used for salads and pickles. [CUCUMIS.] Every gardener knows so much of the cultivation of this plant as to render any general description of the process unnecessary. We only notice a few points. The finest cucumbers are always obtained from shaded plants growing in a warm damp atmosphere, and therefore growing rapidly; this is exclusively owing to the ordinary action of solar light being prevented. Under bright light, evaporation goes on with great force from the surface of the cucumber plant, the quickness of growth is thus diminished, and the fruit is formed in a more solid manner than it otherwise would be, and thus its delicacy is impaired. The effect of direct light moreover is to cause the production of whatever secretions may be natural to a plant; the natural secretions of the cucumber are bitter; hence, the less cucumbers are exposed to direct light while growing, the less bitter, and consequently the more delicate they will be. This sufficiently explains the superiority of cucumbers forced quickly at the dull season of the year, to those produced naturally in the open ground in autumn.

When it is an object to procure very fine and long fruit, the plant should not be allowed to bear early; all the female blossoms should be destroyed until the plant has become vigorous, and well rooted in the bed; a fruit set after that time, will grow much faster than one fertilised at an earlier time.

The best sorts of cucumbers are, for gherkins, the *Russian;* for stewing, the *large white Bonneuil;* for large size, the *Longford;* and for ordinary forcing purposes, any of the *long prickly* sorts, whether *black spined* or *white spined.* The *Smyrna*, which is spineless, and a great bearer, is not in favour with gardeners, for what reason no one can tell. A small sort called the *Sandy* cucumber is grown in the fields in some parts of Bedfordshire, but it is altogether inferior to the *Russian.* A fine table cucumber should have no ribs, be perfectly straight, and the end next the stalk should be as thick as the other end.

CUDBEAR is a violet red powder used in dyeing wool and silk, to which it communicates various shades of brown and purple. It is prepared from the same lichens as archil [ARCHIL] and litmus [LITMUS]; for a list of them see LICHENS, *Colouring matters of.* They are first reduced to a pulp with water, and then treated with ammoniacal liquor from gas-works, or with stale urine to which lime has been added to set free ammonia, constant agitation being kept up in order that the whole may be well exposed to the air. The expressed liquor is either sent into commerce under the name of archil, sometimes called *liquid cudbear;* or thickening materials, such as chalk, plaster of Paris, &c., are added to it, and it is then dried, powdered, and sold as *cudbear*, or less frequently as *persio.*

The colouring matters of cudbear consist of some very beautiful crystalline compounds. [LICHENS, *Colouring matters of.*]

Cudbear derives its name from Dr. Cuthbert Gordon, who first made it an article of trade in this country, at the commencement of the present century.

CUIRASS or CUIRASSE, a piece of defensive armour, made of plate well hammered, serving to cover the body from the neck to the girdle, both before and behind; the front called the breast-, the hinder part the back-plate; these were fastened to each other by straps, buckles, hooks, or some other contrivance. The name is supposed to be derived from *Curatia* or *Curassa*, a Latin word of the middle age, which occurs in charters at least as early as the 14th century (Meyrick's 'Glossary of Military Terms'), originally derived from the French *cuir* or the Latin *corium*, "a hide," the earliest cuirasses being made of leather, though afterwards chiefly of metal, both brass and iron.

This species of armour was known to the Greeks and Romans. A breast- and back-plate of Roman workmanship are preserved among the Hamiltonian antiquities in the British Museum, which, when worn, appear to have been held together by strings or wires, fastened to nipples in front. In later ages the cuirass was disused, and was not revived in Europe till about the beginning of the 14th century. In England it was disused after the reign of Charles II., except in one instance; but has of late years been revived for our cavalry. The cuirass was stated, in Col. Lygon's evidence before a committee of the House of Commons on army and navy appointments, in 1833, to have been introduced as a part of the accoutrements of the Life-Guards within the preceding twelve years. To a question, "Can you state what was the purchase-cost per man of the cuirass?" he answered, "I apprehend they cost nothing; they have been lying in the Tower for years, and were worn at the battle of Dettingen."

In the Romish calendar, under October 14, we find the name of St. Dominic, who is called *loricatus* or the cuirassed, a title given to a saint of the 11th century, who constantly wore an iron cuirass next to his skin.

CUIRASSIERS, heavy cavalry armed with cuirasses. Most of the German powers, especially the emperor of Austria and the king of Prussia, have regiments of cuirassiers. They also form a portion of the French cavalry. In England we have no regiments which go by this denomination, although what are called the life-guards now wear the cuirass. [CUIRASS.]

CULDEES, the name of a religious order in Scotland, Ireland, and the north of England, whose origin may be dated from the middle of the 6th century. The information regarding their origin is chiefly derived from the memoirs of their founder Columba. Their gradual absorption, by the spread of the Roman hierarchy in Scotland, is shown very clearly in the chartularies and other muniments of the episcopal sees and abbacies in Scotland. There have been so many etymologies of the word Culdee, and they are all so purely hypothetical, that it would be a useless effort to attempt a comparative judgment on them.

Unfortunately, the history and institutions of the Culdees have been the subject of dispute between the supporters of the Episcopal and those of the Presbyterian form of church polity: the one maintaining that this primitive body were a mere collection of monastic institutions connected with the Catholic hierarchy; while it is endeavoured to be proved, on the other side, that they were the prototypes of the Protestant Presbyterians, and that their church polity was derived from the fountain-head of Christian truth, and communicated to modern times through the Lollards, before the Culdees were entirely extinguished. They have in this respect been compared with the Waldenses. The Culdees undoubtedly formed a part, if not the whole, of that early Scottish Church, which had established a different epoch for the celebration of Easter from the Western Church,—a subject subsequently productive of much dispute between the Scottish and English ecclesiastics. The ground on which the former maintained their own peculiar usages was, that they had been derived directly from the apostles, by whom, and not by the ecclesiastical representatives of St. Peter, the Church in Ireland had been planted. The practice of the Culdees seems to have so far coincided with the later monastic institutions, that they lived in retirement, practised abstinence, and made devotion and the administration of religious and charitable functions their chief pursuits. So far were they, however, from adopting a rule of celibacy, that marriage was practised and reckoned honourable among them. It is difficult to discover their precise polity. It has been found that they ordained bishops; but it farther appears that the persons bearing that name, instead of having any absolute authority over another class as Presbyters, were themselves under the authority of the president, or head of the establishment, as representing the community. The Culdees had establishments in various parts of Scotland, many of them in the form of colleges, where they kept small libraries of manuscripts, and gave instruction to youth. Their principal establishments, besides that of Iona, were at Oronsay, Abernethy in Perthshire, the island of St. Serf in Lochleven, Dunkeld, St. Andrew's, and Monymusk in Aberdeenshire. Efforts have been made, though apparently without success, to identify these establishments with the episcopal dioceses, and to prove that each college or monastery, with its head and ordinary members, was virtually the dean and chapter of the diocese; but it is better supported that the first bishops were Culdees, and that they were elected from among the pastors by the votes of this body. The archiepiscopal see of St Andrew's appears to have owed its early predominance to the Culdees, who seem to have had considerable possessions in the neighbourhood. The great abbey of Arbroath is believed to have had a similar origin, and so is that of Melrose. Besides the dispute as to the holding of Easter, and the difference of opinion on the marriage of ecclesiastical persons, the Culdees had many subjects of dispute with the Romish hierarchy, from whose customs they seem to have diverged on the subject of auricular confession, and various others. They were at last obliged to give way before the waxing influence of the Church of Rome. St. Bernard describes the people as beasts and barbarians, who "neither pay tithes nor first fruits. They do not enter into lawful marriage; they do not go to confession; no one can be found who applies for the prescription of penance, nor any one who will prescribe it." The erection of the several bishoprics, under the patronage and countenance of the kings of Scotland, raised up powerful enemies to the Culdees who were within the respective territories allotted to them as dioceses, and the order was thus gradually incorporated with the Romish Church.

(Jamieson, *Historical Account of the Ancient Culdees of Iona, and of their Settlements in Scotland, England, and Ireland*, 4to, Edinb. 1811; Maccallum, *History of the Culdees*, 12mo, Edinb. 1855; Keith, *Catalogue of Scottish Bishops.*)

CULMINATION (*culmen*, the summit of a thing). A star culminates, or comes to its highest point, at the moment when it is on the meridian. [TRANSIT; MERIDIAN.]

CULVERIN. [ARTILLERY.]

CUMENE. [CUMINIC ACID.]

CUM-EUGENYL. [CARYOPHILLIC ACID.]

CUMIDINE. [CUMINIC ACID.]

CUMINAMIDE. [CUMINIC ACID.]

CUMINIC ACID ($C_{20}H_{12}O_4$). Cuminic acid and its derivatives form a group of bodies which are entirely homologous with the benzoic acid group.

Cuminic Aldehyde, Hydride of Cumyl, Cuminol ($C_{20}H_{12}O_2 = C_{20}H_{11}O_2H$). This body, which is the starting point for the preparation of most of the cuminic derivatives, exists in a free state in the etherial oil of cumin (*Cuminum cyminum*), along with a hydrocarbon cymole. When this oil is treated with an alkaline bisulphite, a crystalline compound of the aldehyde with the bisulphite is formed, and this compound, freed from foreign substances by pressure between bibulous paper, yields on subsequent treatment with potash, hydride of cumyle.

When pure, hydrate of cumyl is a colourless or slightly yellow liquid, with a strong odour of cumin, and a bitter acrid taste. It boils at 428° F. Exposed to the air, or still more rapidly when treated by oxidising agents, it assimilates oxygen, and becomes converted into cuminic acid. Treated by potassium, hydrogen is liberated, and *cumylide of potassium* ($C_{20}H_{11}KO_2$) is formed.

Cuminic Acid ($C_{20}H_{12}O_4 = HO, C_{20}H_{11}O_3$). When hydride of cumyle or oil of cumine is dropped on fused hydrate of potash, hydrogen is liberated, and cuminate of potash is formed:—

$$\underbrace{C_{20}H_{12}O_2}_{\text{Hydride of Cumyl.}} + \underbrace{KO\,HO}_{\text{Potash.}} = \underbrace{KO, C_{20}H_{11}O_3}_{\text{Cuminate of Potash.}} + 2H$$

When the fused mass is dissolved in water and decomposed by hydrochloric acid, the cuminic acid is precipitated, and after crystallisation from alcohol is obtained in the form of beautiful colourless plates. It is a monobasic acid; its salts have the general formula $C_{20}H_{11}MO_4$. They are of little importance.

When cuminic acid is treated with nitric acid there is formed, according as the action is modified, *nitrocuminic acid* ($C_{20}H_{11}(NO_4)O_4$), or *binitrocuminic acid* ($C_{20}H_{10}(NO_4)_2O_4$). By the action of pentachloride of phosphorus, the *chloride of cumyl* ($C_{20}H_{11}O_2,Cl$) is formed:—

$$\underbrace{C_{20}H_{12}O_4}_{\text{Cuminic acid.}} + \underbrace{PCl_5}_{\text{Pentachloride of phosphorus.}} = \underbrace{C_{20}H_{11}O_2,\ Cl}_{\text{Chloride of Cumyl.}} + HCl + \underbrace{PO_2Cl_3}_{\text{Oxychloride of phosphorus.}}$$

This is a colourless liquid, which fumes in moist air, and boils at 493° F. By water it is decomposed into hydrochloric acid and cuminic acid, and by ammonia into *cuminamide* ($C_{20}H_{13}O_2 = N\left\{\begin{matrix}H\\H\\C_{20}H_{11}O_2\end{matrix}\right)$). Cuminamide is also formed when cuminate of ammonia is distilled. It resembles benzamide.

Anhydrous cuminic acid ($(C_{20}H_{11}O_3)_2$) is formed by the action of chloride of cumyl on cuminate of soda. It closely resembles the corresponding benzoic compound.

Cumole ($C_{18}H_{12}$), *Hydride of Cumenyl, Cumene,* is formed when cuminic acid is distilled with excess of caustic baryta:—

$$\underbrace{C_{20}H_{12}O_4}_{\text{Cuminic acid.}} + \underbrace{2BaO}_{\text{Baryta.}} = \underbrace{2BaO\ CO_2}_{\text{Carbonate of baryta.}} + \underbrace{C_{18}H_{12}}_{\text{Cumole.}}$$

It also exists in coal-tar naphtha, from which it is separated by fractional distillation. It boils at 292° F. It is homologous with benzole, which it greatly resembles, and under the influence of various agents it undergoes a series of changes exactly similar to those of that body. Thus, there exists a *nitrocumole* ($C_{18}H_{11}NO_4$), and *binitrocumole* ($C_{18}H_{10}(NO_4)$). The former, under the influence of reducing agents, is converted into a compound ammonia, *cumidine,* ($C_{18}H_{13}N = \left.\begin{matrix}C_{18}H_{11}\\H\\H\end{matrix}\right\}N$) an oily liquid, which with acids forms crystallisable salts. There is also a *sulphocumenic acid* ($C_{18}H_{12}S_2O_6$), homologous with sulphobenzolic acid.

Cuminic Alcohol ($C_{20}H_{14}O_2$). When cuminic aldehyde is treated with potash ley of moderate concentration, it undergoes a change analogous to that experienced by its homologue, benzoic aldehyde, under the same circumstances, being converted into cuminic acid, and cuminic alcohol:—

$$\underbrace{2(C_{20}H_{12}O_2)}_{\text{Cuminic aldehyde.}} + \underbrace{KO\ HO}_{\text{Potash.}} = \underbrace{C_{20}H_{11}O_3KO}_{\text{Cuminate of potash.}} + \underbrace{C_{20}H_{14}O_2}_{\text{Cuminic alcohol.}}$$

This alcohol is a colourless liquid, with a feeble aromatic odour, and an acrid taste. It is insoluble in water; it boils at 470° F. Like its homologue, benzoic alcohol, with which it has great similarity, it has all the properties of an alcohol. It decomposes under the influence of re-agents into products analogous to those furnished by ordinary alcohol, the difference being that from the greater complexity of the molecule it is more difficult to produce these changes.

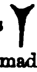
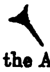
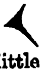
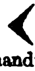
CUMINOL. [CUMINIC ACID.]

CUMOLE. [CUMINIC ACID.]

CUMONITRILE ($C_{20}H_{11}N$). This body, which is the cyanide of cumenyl ($C_{18}H_{11}Cy$), is obtained by heating cuminate of ammonia. It is a colourless oily body, of an agreeable odour.

CUMYL ($C_{20}H_{11}O_2$). The hypothetical radical of cuminic acid. [CUMINIC ACID.]

CUMYL-SALICYLAMIDE ($C_{34}H_{17}NO_6$). A crystalline amide obtained by the action of chloride of cumyl upon salicylamide. [AMIDES.]

CUNEIFORM or CUNEATIC. These words, as well as arrow-headed, nail-headed, and wedge-formed, describe the oldest written characters used in the country about the Tigris and Euphrates, and subsequently in Persia. All refer to the strokes or elements of the characters which were thought by travellers who saw the tablets on which they were inscribed, to represent wedges or the heads of nails or arrows: they vary from a neatly formed stroke like this  to a clumsy triangular wedge. There are two distinct alphabets made up of these wedges or arrow-heads; the older one, called the Assyrian or Babylonian, consists of more than two hundred characters, in which the wedges are placed horizontally, perpendicularly, and obliquely, often crossing each other in all directions; the oblique wedge frequently becomes an angular hook, from the lengthening of one side of the head: thus,  becomes , and at length . The Babylonian differs from the Assyrian little more than the handwriting of one man from that of another. The more recent alphabet was used in Persia; it consisted of thirty-six letters only, the strokes were all horizontal or perpendicular, and with one exception they were never made to cross each other. This second alphabet is very distinctly formed in all the cases that have come down to us, no one letter is at all doubtful, and the words are separated from each other by an oblique stroke.

Of the above alphabets the older one appears on monuments dating at least twenty centuries before the Christian era, and documents are found written with it which come down to the time when Alexander's successors were ruling in Western Asia. In that long interval it underwent many modifications, which greatly disguise its identity; but a careful investigation will show that the characters do not differ more than the Roman, Italic, and old English types now in use; not so much as the variously contorted letters we see occasionally, intended by their contrivers to be ornamental. This alphabet was used in writing at least four different languages, only one of which has been studied to any great extent; it is a most cumbrous alphabet, almost equalling the Egyptian in clumsiness and imperfection. The other alphabet was used in the Persian empire only, where it appears to have been introduced by the elder Cyrus, and it is found in documents of the time of Artaxerxes Ochus; it lasted, therefore, a couple of centuries, from 540 B.C. to 340 B.C. This was a true alphabet of thirty-six letters; it is easily read, the words are separated, there is very little variety of form in the letters, and it was used solely for the principal language of the Persian empire.

It may be said that there is a third alphabet, the one used in the so-called Scythic inscriptions of Persia, but this is really a modification of the first mentioned Assyrian alphabet; it is somewhat simplified, and it rejects the more complex forms. So far as we know, it was employed solely for the Scythic versions of the inscriptions of the Achemænian dynasty; and its duration was also from the reign of Cyrus to that of Artaxerxes Ochus.

These three kinds of writing almost without exception are found together, in the inscriptions of the Achemænian period, in the Persian empire; all such monuments contain the same notice or statement in the three languages and alphabets. The writing upon the highest or most prominent tablet is called universally the first kind; we should be inclined to call it the Median writing, as being in the language of the most numerous and civilised of the inhabitants of the Persian empire, if the Median name had not hopelessly yielded to that of the Persians, the energetic race of the province of Persis, who imposed their rule upon Media, in the same way as the energetic German-Franks imposed their own national denomination over all Gaul. The next in place on the monuments is that modification of Assyrian used for a Turanian language; it is called "the second kind," as well as Median and Scythic; the language may have been that of the province of Persis, and placed so high on the inscriptions as being the tongue of the native province of Cyrus. The third in place is the Babylonian; the language of the most literary portion of the Persian empire, which was necessary for the dissemination of a knowledge of the inscriptions over its western provinces. The employment of this version has proved the stepping-stone to the decipherment of the Assyrian language and character, almost identical with Babylonian, without which we are confident that the relics of Assyrian literature, found in such abundance within these few years, could never have been by any possibility understood.

All the early accounts of cuneiform inscriptions refer to the monuments of Persia; they were all visible, and in lofty places, while those of Assyria were buried among the ruins of cities, luckily far out of reach, to be found at the very moment when only could there be any hope of ascertaining their value, when a few learned scholars had succeeded, after thirty years' labour, in reading the easier monuments which were to give a clue to the intelligence of the more mysterious relics now coming into view. All attempts at decipherment had been confined, with hardly an exception, to the first kind of writing, until the labours of Layard and Botta, in and about the mounds of the long-lost, almost fabulous Nineveh, brought to the knowledge of Europe the vast treasures of Assyrian civilisation, and, in the majority of instances, not only the knowledge of their existence, but the monuments themselves; not only the great advertisements posted up on the walls of the empire, as in Persia, but thousands of the books intended to be consulted in the study. These books are closely written slabs of dried clay, from a pocket edition of two inches by one and a-half, or even less, to a quarto slab of eight inches by six. We frequently find also, barrel-shaped masses of terra-cotta, from four to seven inches long, and six to ten inches in circumference; and when the document was larger it was written on a prism of six, eight, or ten sides, from twelve to twenty inches long; one has been found in fragments, which may have been more than thirty inches long. These prisms had a hole through their length, as though intended to be mounted like a roller, and turned round to present its sides in succession to the reader. The writing on all these terra-cotta books is small, from six to ten lines in an inch, but some words are occasionally much smaller, like notes, of which sixteen at least might be included in an inch. The long-during burial of these oldest specimens of literary labour, while it has for so many centuries kept from the world such abundant sources of our knowledge of ancient history, has done us the great service of preserving these fragile relics in as perfect a condition as they were in when first buried under the ruins of Assyria; many of them are as fresh as when they came from the hands of the moulder, with the burred edge made by the writing-tool upon the soft clay still perfectly visible. Some of the most fragile and ill-baked records that may hardly be touched without damage, have nevertheless reached us quite perfect; while others much harder have been so rubbed as to be half unintelligible. The barrels and prisms have, in many instances, been found in excellent condition, and even when broken are complete and easily mended; but most unfortunately the slabs, with the exception of the very smallest, are all broken in pieces with obvious design, so that not one is entire, and although the fragments have been carefully looked over, and all those cemented which were found to fit, yet scarcely a single specimen has been completed. Further research will probably bring to light many missing fragments, but the work cannot be trusted to those who have not made some study of the language, and these are more congenially employed in reading what is before them, than in the tedious labour of searching through heaps of dusty fragments, often finding nothing after hours of toil.

The first notices of cuneiform inscriptions, so far as the writer is cognizant, were brought to Europe by Pietro della Valle about 250 years ago; and towards the close of the 17th century, Tavernier and Kæmpfer published some imperfect specimens, which were followed by those of Chardin a few years afterwards. The first publication of a connected inscription was made by Le Brun or Bruyn, at Amsterdam in 1714; in the compartment numbered 131 of a large plate in his second volume at page 272, he gives in the three languages the inscription of Xerxes, marked C by Lassen, and 17 by Rawlinson, who has translated it at page 337 of his 'Memoir.' In 132 he has Rawlinson's No. 2, a very short inscription of Darius; but the commencing letters of each line are omitted: in 133 he gave some unconnected lines from more than one inscription, some in each of the three languages, but all imperfect; and in 134, the window inscription of Darius which had also been printed by Kæmpfer and Chardin. Most of these engravings of Le Brun may now be readily understood, although they contained many errors which would have sadly misled a decipherer. The first really good copies of the Achemænian monuments were published by Niebuhr a century ago, and these constituted the basis of all the investigations made with a view to decipherments up to the time when Colonel Rawlinson copied the great Behistun inscription, now twenty-five years ago, giving an impulse to the study of these monuments, which has resulted in such brilliant success. Niebuhr's copies were before the world half a century before any reasonable attempt was made to ascertain their tenor; and it is somewhat amusing now to run over the guesses made by really learned men: the most moderate believed they were mere ornaments carved at the caprice of the architect; one savant decided that they were charms or talismans; another read in them passages from the Koran; a third found great mysteries connected with magic and astrology. The first step made in the right direction was by Professor Grotefend, of Hanover, who collated a series of names, which there was good reason to believe to be those of the Achæmenian kings of Persia. Grotefend thus identified the names of Darius, Xerxes, and Hystaspes, and the substantives, "king" and "son;" and if he had possessed a competent knowledge of Sanscrit, he would in all probability have carried his decipherments, in a very short time, to the point which was not reached by the united efforts of Burnouf and Lassen till 1836. As an instance of sagacity defeated by want of knowledge, we may mention that the word "son," in Sanscrit *putra*, was read *bun*, because he was told told that the term *buns* was current with this meaning in India. *Buns* was the Bengalee mode of pronouncing the Sanscrit *vansa*, "a family;" the wrong application of *n* was for a long time a source of error, and it was not till 1838 and 1839, that Rawlinson and Lassen discovered the true reading of *putra*. Some twenty years after Grotefend's first step, Mons. St. Martin made an advance in reading the name of Hystaspes *Vishtaspa*, which Grotefend had made *Goshtaspa*. A more important step was made by Rask three years after, in a pamphlet printed at Copenhagen in 1826; he made known the nasals *m* and *n*, showed the accusative case ending in *n*, and the genitive plural in *anām*; and it would seem, might have enabled a good Sanscrit scholar to read everything which the Achemænians had left behind them; but so slow was the progress made, perhaps from the little confidence felt by scholars in what had been already discovered, that nothing of value was made known for ten years after this, when Burnouf and Lassen independently published their readings of one of Niebuhr's inscriptions, pl. xxxi., containing the enumeration of the Satrapies of the Persian empire; a list of twenty-three names, which are among those given by Herodotus; this list had already in 1832 been imperfectly rendered by Grotefend. In 1838, two years subsequent to those important publications, Col. Rawlinson sent from Teheran to the Royal Asiatic Society his first communication on the inscription of Behistun, a great part of which he had copied with much difficulty and some danger. This communication, which was dated January 1, 1838, contained a transcript in Roman characters, with a translation, of the commencing paragraphs of that inscription, and every letter was read as now admitted by the common consent of all who have studied the subject. This was a promising essay, which was followed by details on the alphabet, and a précis of the contents of the inscription of Behistun. But the Affghan war compelled Col. Rawlinson to leave the scene of his peaceful labours, and nothing from him appeared in print until eight years afterwards, except very brief notices in the 'Athenæum' and 'Literary Gazette,' and in the annual 'Reports of the Royal Asiatic Society's Proceedings.'[*] At length, in the year 1846, the Royal Asiatic Society issued a volume containing the whole of the Behistun inscription, in fac-simile, together with a very complete analysis and literal translation, accompanied by copies and versions of all the Persian inscriptions which were then known to exist; to which very few additions have been made since. This volume contains also a general history of the discovery and decipherment, and a detailed memoir on the alphabet. While the work was yet printing, a letter was read from Col. Rawlinson, dated at Bagdad, August 26th, containing an additional chapter, in which the colonel communicated his discovery of inherent vowels in the letters of the alphabet, the effect of which was to bring the grammatical forms of the ancient Persian into the closest analogy with those of Zend and Sanscrit, and to remove the many anomalies attending the mode of transcription hitherto adopted. This was an important discovery for the philologist, though it added little, if anything, to the intelligence of the inscriptions; and it is a curious fact, that the same discovery was made simultaneously by the Rev. Dr. Hincks, of Killyleagh, in Ireland; a gentleman who has distinguished himself by very great acumen in all the varieties of cuneiform writing. This volume exhausted the subject of the Persian writing, and satisfied the learned that the decipherment rested on a secure foundation. The inscriptions were republished in the following year at Leipzig, by Professor Benfey, with Col. Rawlinson's versions translated into German, accompanied by a vocabulary; together with an introduction, in which the learned professor expresses himself with warm commendation of the sagacity and learning displayed by Col. Rawlinson in this valuable work. There remained now the second or Scythian kind, and the far more important Babylonian, which was to lead us to an understanding of the very ancient and not then discovered literature of Assyria.

It may be of some interest to show what is the historical result of these discoveries in the easiest and first found, but chronologically the latest cuneiform alphabet. We proceed to do it very briefly. The oldest inscription is one of Cyrus, repeated four times on the ruined pillars of Pasargadæ; it says simply, "I am Cyrus, the Achemænian." Darius has one still shorter, without the epithet, and seven of various lengths from half a dozen to sixty lines, besides the important monument of Behistun. All those of any length contain invocations to Ormuzd, and two have lists of the provinces of Persia, the latest of which in date, engraved on the tomb of Darius, included a number of names omitted in the former; probably recent annexations. Of Xerxes, the son of Darius, there are eight inscriptions, the longest having thirty lines, all of similar purport to the smaller monuments of Darius. One of Artaxerxes Mnemon was discovered at Susa after the publication of Col. Rawlinson's memoir. It contained five long lines, but it was imperfect. In this monument the king records the placing of the statues of Anaitis and Mithra in the temple of Ormuzd, and he invokes the protection of the three deities. A much longer inscription of thirty-five lines was erected by Artaxerxes Ochus, who, after the usual invocation to Ormuzd, details his pedigree up to Arshama the father of Hystaspes. It is curious that this inscription, as well as that of Mnemon, is full of gross errors of grammar, showing that the language had greatly deteriorated in the course of a century and a half, or what some may think more probable, that the language of the inscriptions was already a learned language in the earlier times of the monarchy, and that the study of it had not been kept up. The writer is inclined to believe that the old Median language had been affected by the Persian conquest; the verbal forms are not much damaged, but cases and declensions are in hopeless confusion. The difference between the styles of Darius and Artaxerxes, is as great as that found between the Anglo-Saxon of the 11th century, and the language of the century following the Norman conquest. A smaller inscription of Artaxerxes was also found at Susa, and another is in the Treasury of St. Mark, at Venice, on a vase, where it is repeated in Scythic and Babylonian, and also in regular Egyptian hieroglyphics.

The great inscription of Behistun deserves a separate notice. Its position is 300 feet from the foot of the rock, where it could not have been engraved without scaffolding; the face of the stone was carefully smoothed, and in unsound or defective places other pieces were artistically laid in, and fastened with molten lead; so nicely is this done, that according to Col. Rawlinson, "very careful scrutiny is required at present to detect the artifice." The engraving is executed in letters above an inch long, with an elegance and uniformity almost unequalled, and the whole surface was afterwards covered with a siliceous glaze of extraordinary hardness, very much of which remains on the rock, while portions that have become detached are still found in masses on the ledge at the foot.

Darius begins his inscription by tracing up his genealogy to the eponym of his family, and then enumerates the 23 provinces of his empire. He recapitulates the murder of Smerdis by his brother Cambyses, the death of Cambyses, the insurrection of Gumata (the Cometes of Justin), his death, and his own accession to the throne. We have in this the narrative of Herodotus, without the romantic stories detailed by the credulous or imaginative Greek. The first care of Darius was to restore the national worship which Gumata had neglected. While thus occupied, a revolt broke out in Susiana, and almost simultaneously another in Babylon under the conduct of a man whom Darius calls a pretender, assuming the renowned name of Nebuchadnezzar. The first revolt was easily quelled by the generals of Darius; that of Babylonia yielded only to the presence of the monarch, who after two successful battles followed the pretender to Babylon, and slew him there. While still in Babylon nine provinces took the opportunity of rising, from Assyria in the north to Egypt in the south, and even his own native Persis was one of the rebellious districts. The latter was easily quelled; but six battles were fought with very partial success against the insurgent Medes and Assyrians, who were not subdued until Darius himself took the field: he fought a battle with the Median chief, who was named Phraortes, at a place called Gundrus, and put him to flight. Phraortes escaped to Rhages, where he was captured, and brought to Darius, who cruelly tortured him, and subsequently put him to death at Ecbatana.

---

[*] See 'Athenæum,' April 14, 1838, No. 546, p. 275; Dec. 12, 1838, No. 582, p. 915; 'Literary Gazette,' Dec. 22, 1838, No. 1144, p. 809; and Asiatic Society's 'Annual Reports,' May, 1838, p. ix., and May, 1840, p. 9.

The next insurrection was in Sagartia, but the leader of the revolt, who assumed, like Phraortes, to be of the royal race of Media, was soon defeated, and put to death, after torture, at Arbela. Another revolt followed in Parthia, which was subdued by Hystaspes, the father and lieutenant of Darius, after two engagements, in the second of which he was aided by troops which his son supplied. A province of Bactria then raised the standard of rebellion, but this was quelled in one battle by Dadarses the satrap of Bactria. And now another false Smerdis arose in Persis, who gave Darius much more trouble; he made a diversion by despatching troops to Arachosia, who excited that province to revolt also. Five battles were fought, two in Persis, and three in Arachosia, in none of which Darius was present, although he appears to have been in that part of the empire. Finally the rebellion was quelled, and the chiefs were captured and put to death. In the mean time Babylon revolted again under an Armenian, who, like the former insurgent, took the name of Nebuchadnezzar, but he was defeated by the general of Darius, and crucified in Babylon.*

Here the historical part of the inscription ends, and the monument was probably erected during the period of tranquillity which ensued; but it appears from a short column subsequently added, which is very much damaged, that another revolt broke out in Susiana, which was quelled by Gobryas, the general of Darius; and again another among the Scythians on the Tigris.

The closing column of the inscription is filled with the names of the defeated rebels, whom Darius here calls kings, with asseverations of the truth of the record, a considerable amount of self-glorification, and blessings and curses invoked on the preservers and destroyers of the monument respectively; the whole concludes with the names of the six men who assisted in the death of the Magian, the false Smerdis, and a recommendation of their descendants to the monarch's successor.

We have much less to say of the second branch of the subject; historically, nothing; as the contents of the inscriptions are merely translations of those above described. The first treatise upon these inscriptions specially, by Westergaard, was published in the 'Transactions of the Northern Antiquaries of Copenhagen,' in 1845. This was a very careful analysis of all that had been then published, and considering the limited materials at his disposal, it is a monument of the learned Dane's sagacity. The memoir of Norris, published in the Royal Asiatic Society's Journal, in 1853, had the advantage of a greatly increased quantity of material, Sir Henry Rawlinson having placed at the writer's disposal the paper casts of the great inscription of Behistun, which enabled him to show the value of many characters not ascertained previously: out of 105 characters he found the approximate sound of 84, and in most of these he agrees with Westergaard. In regard to the language, Norris's opinion was, that it belongs to the Turanian division; and he was inclined to look upon it as more like the Ugrian branch than any other, although agreeing here and there in its vocables rather with Mongol or Turk. The Turanian division of languages includes a very large number of tongues, with far greater differences than those found in the Indo-Germanic or Semitic families in their largest extent, and any features in which all agree are rather negative than positive. Norris suggests, in p. 52, that the cuneiform system was invented by a Scythic nation, which seems to be confirmed by the discovery of the præ-Semitic inscriptions of Nineveh, and by the investigations of Oppert. He also gives some reasons, in p. 205, for a supposition that the natives of the province of Persis were Scyths; possibly they spoke the language of the inscriptions of the second kind, which may have been adopted by Cyrus in preference to the dialects of the other barbarous tribes of the empire, because it was that of his native province. Norris suggested that the dialect was that of Susiana, but nearly all the inscriptions found in Susa are in a different though probably allied language.

The value of this part of the investigation is merely philological; unless it may by-and-bye afford a clue to the other languages which we find written in cuneiform characters, and it may even aid in deciphering the præ-Semitic Turanian tablets, which reach to 2000 B.C.

We now come to the Assyrian or Babylonian inscriptions, a branch of the inquiry quite unnoticed when the subject was first studied, but which now, from the great number of relics found, and their far more ancient date, extending to a period when all profane history is silent, has arrived at dimensions that have thrown all the rest into the shade. The brilliant results of the researches in and about Nineveh have been already mentioned, and we have spoken of the very large numbers of earthen blocks and slabs brought home, the principal vehicle for the literary labours of the Assyrians, nothing having been found in any way resembling parchment or paper. There is no doubt, however, that something of the sort existed; perhaps leather skins; we find in several bas-reliefs now in the British Museum, which represent the enumeration of things required to be numbered, such as the cattle passing through the gate of a city, or the more favourite occupation of counting a heap of heads cut off from the king's enemies,—two men pictured with writing materials in their hands, one of them having a little slab with a pointed tool digging into its surface, and the other usually provided with a flexible roll, the end hanging loosely down, upon which he is obviously writing with ink—no doubt checking his companion. The contemporary records of the Bible show the same usage. Isaiah, viii. 1, mentions a roll for writing; and in xxxiv. 4, the rolling of a book is alluded to. Of the etymology of these words, from a verb signifying *to roll*, there is no doubt; about the ink of Jeremiah (xxxvi. 18), and the inkhorn of Ezekiel (ix. 2), there is less certainty, although the usual acceptation of the words is probably the right one.

The decipherment of the third class of cuneiform inscriptions is due mainly to the sagacity of Sir Henry Rawlinson, though much has been done by Dr. Hincks and Mons. Oppert. Sir Henry was favourably placed at Bagdad for making himself acquainted with the inscriptions found by Layard, which passed through his hands on their way to England; he had a critical knowledge of the Arabic language, and he was not unacquainted with the other Semitic tongues. As soon as he saw the value of the new discoveries which Layard and Botta were copiously bringing to light, he quitted the study of the first branches of the investigation, now almost exhausted, and plunged eagerly into the new mine. In spite of all the difficulties attending the clumsy and enigmatical Assyrian mode of writing, which can hardly be called an alphabet, he made rapid way, aided by the unfortunately much-damaged version of the Behistun inscription in the Babylonian language and character, which were sufficiently like the Assyrian to enable a philologer to make his first steps with confidence. Into the details of the decipherment this is not the place to enter. Colonel Rawlinson's memoir, containing his analysis of a considerable portion of the great Babylonian inscription, was printed in 1851 by the Royal Asiatic Society. This still awaits completion; but enough is given there to enable a man with a good knowledge of Semitic languages, Hebrew especially, to read many passages in any historical monument. It has already in this country enabled Mr. Fox Talbot to translate nearly the whole of the annals of Tiglath Pileser I., and some portions of the hieratic slab of Nebuchadnezzar which was presented to the East India Company in the beginning of this century. The frequent admixture of the forms and words of the ancient race who preceded the Assyrians in the lands watered by the Tigris and Euphrates, the probable inventors of this mode of writing, concur with the clumsy adaptation of the alphabet to puzzle the most learned and energetic investigator in many places. The number of vocabularies found in the ruins of palaces, upon which the ancient Turanian words are explained in ordinary Assyrian, shows that the difficulty was felt twenty-six or twenty-seven centuries ago, when the language was vernacular: we may expect to find it greater now. The difficulties are gradually diminishing, but much remains to be done; and the very fragmentary condition of the vocabularies found will perhaps render a complete knowledge of Assyrian impossible. But we do not despair; the first part of the 'Corpus Inscriptionum,' compiled by Sir Henry Rawlinson, and printed at the cost of government, is already completed, comprising 70 large sheets of monuments, chiefly historical, beginning with the stamped bricks of the ancient Turanian monarchs of twenty centuries before the Christian era, and proceeding downwards to the annals of the successors of Nebuchadnezzar. A second part is in preparation, which will contain vocabularies, mathematical tables, astronomical observations and calendars, mythological tablets, lists of dynasties, descriptions of countries, rivers, and mountains, classified lists of animals, and a great variety of miscellaneous matter. When the united efforts of some dozen patient and energetic learned men shall be brought to bear upon this mass of material, we may hope that every thing will be discovered which is not really impossible.

A good many Assyrian inscriptions have been found in the hieratic character, which diverges from the ordinary form much in the same way that the various monkish forms called Gothic, Old English, &c., differ from the Roman type. These would have formed a more serious difficulty but for the discovery of a fragment, now in the British Museum, which was very accurately engraved and published by Ker Porter. This proved to be, so far as it went, a copy in cursive character of the great inscription of Nebuchadnezzar, engraved in the complex hieratic character. Three of the inscriptions in the volume mentioned above, prepared by Sir Henry C. Rawlinson, are in this character.

---

* It is curious that, after mentioning a battle, the Babylonian version always records the numbers of the killed and taken; a particular neglected by the less mathematical Medes and Persians. The love of calculation was certainly active in the Babylonians, and was more beneficially directed in their astronomical labours.

The inscriptions of Van in Armenia, copied by Schultz, and published by the Asiatic Society of Paris, have not yet been read. A fair commencement was made by Dr. Hincks in the ninth volume of the Royal Asiatic Society's Journal, 1848. Dr. Hincks gave some strong reasons for considering the language to be of the Indo-Germanic family; but we are not aware that he has followed up his investigations.

The incriptions of Susa appear to be in a Turanian language; but they have not yet been seriously investigated, and, in fact, they are too few to afford much scope to a decipherer. Several of the words appear to be identical with those of the inscriptions of the second class; but the alphabet is on the whole more complex than that of the Assyrian class.

The language of the predecessors of the Assyrians, who appear to have been named Accadi, will form a more serious study; the considerable number of slabs in their language now in the British Museum, and the continued influence of that language upon, or at least admixture with, the Assyrian of all the monuments, will by-and-bye excite more attention than it has yet met with. A small grammatical tablet, on which the Accad forms are compared with the Assyrian, was copied by Mons. Oppert, who has also published in Paris a valuable historical sketch of the history of cuneiform decipherment.

A few remarks may be allowed on the reality of cuneiform decipherment, as doubts have often been expressed in relation to this reality. It has been vehemently disputed by some persons of note, though we are not aware of the grounds of their objections. We have heard of two arguments only, and they are mutually destructive; the one is that no decipherment is trustworthy that does not concur with some independent testimony; the other that independent testimony renders the result suspicious, because a decipherer would, even unconsciously, suit his readings to such testimony: as in the case of the genealogy of Darius, where the Behistun monument agrees with Herodotus. With regard to the Persian inscriptions, written in a limited alphabet, with words clearly separated, a denial of the possibility of decipherment would be tantamount to denying that any writing in unknown characters could ever be deciphered; a feat easily accomplished by a clever schoolboy in his own tongue, while the circumstance that a decipherer works upon a language not his own could do no more than make the task difficult, provided that the language to be read was one that the decipherer knew something of. It would puzzle a man to contrive a false alphabet which would make sense of a short English inscription of a dozen words only, and the credulity must be very ample indeed that could swallow such a contrivance in the case of an inscription of five hundred lines. There would be more reason to doubt of the reality of Assyrian decipherments, because of the complicated mode of writing used, if we had not at our disposal a pretty long bilingual (in fact trilingual) inscription, in which one of the languages is Assyrian, and another read partially at least. This inscription contains a large number of names, and thus it gave us many letters of our new alphabet. A reasonable objection brought forward to the reading of these monuments lies in the alleged existence of polyphones, or characters having several powers. No doubt some difficulty arose from this, but it has been overrated; we have something like it in our own *c* and *g*, which letters have two sounds each. But, strictly speaking, we believe there are few, if any, polyphones; each letter has one sound, though some have several significations. An analogy with this may be see in our letter *x*, which has one sound but several values. Most Englishmen seeing Xber, Xtmas, Charing X, Charles X., will at once read December, Christmas, Charing Cross, and Charles the Tenth, but they would hardly say that *x* had five phonetic powers. The Assyrians had several such characters, but their use was limited, though the reader must have been occasionally in doubt. But reading is a difficult task in most Oriental nations, and the accomplishment could hardly have been universal in Assyria, nor would written works be so numerous as to demand much rapidity in reading. If many books existed, we are inclined to believe that they were written on skins or leaves, in some less cumbrous writing than that of the monuments which have survived the lapse of so many centuries; and traces of such writing appear here and there on the Assyrian bricks, not yet read, but having some resemblance to Phenician.

On the whole we do not hesitate to express our conviction that the decipherers of Assyrian are on the right path, and that simple narrative passages are now read with tolerable accuracy; but it will require the united efforts of many scholars, and the compilation of a dictionary, in which the varying forms constituting the power and the difficulty of Semitic languages shall be brought under their respective roots, and their values thus specified, before the long lost monuments now so happily discovered shall be completely understood.

CUPEL; CUPELLATION. [ASSAYING.]

CUPID. [EROS.]

CUPOLA. [DOME.]

CUPPING is of two kinds: one by which some blood is taken away, generally simply termed cupping; the other when no blood is abstracted, which is accordingly termed dry cupping. The preliminary steps of the operation are the same in both cases: the part to which it is intended to apply the cupping-glasses is washed with warm water, or a warm cloth is merely applied to it, in order to attract blood to the part. A small bell-shaped glass, a portion of the air of which has been expelled by holding it for an instant over the flame of a spirit-lamp, is immediately applied to the spot which has been prepared. The usual amount of pressure on the part being diminished, the blood flows to the part, and produces distension of the vessels and elevation of the surface, as well as a purple or livid colour. If it be intended to take away blood, the cupping-glass is speedily removed, and an instrument called a scarificator, containing a number of lancets, sometimes as many as twenty, is applied, and made to act so as to inflict a corresponding number of incisions on the skin and subjacent vessels. "The instrument is so constructed, that the depth to which the lancets penetrate may be made greater or less at the option of the practitioner." It is not in general advisable that the depth should be very great, as more blood flows, and the vessels will continue to bleed longer, if only partially divided, than if completely cut through. The cupping-glass, exhausted as before, is to be immediately replaced, and if skilfully applied, and the air has not been too much rarefied, by which too great pressure is made by the edges of the glass, a considerable quantity of blood will flow into it. When nearly full, or if the blood begin to coagulate, the glass is to be carefully removed, the wounded part quickly washed with a sponge with warm water, and the glass having been emptied and washed, is to be again applied, if a sufficient quantity of blood should not have been obtained by the first application. Two or more glasses may be applied to different spots at the same time, so that the quantity of blood desired, or necessary to obtain the object in view, may be more quickly abstracted.

"Where dry cupping only is intended, the glasses may be permitted to remain on the skin for a few moments, and replaced five or six times, with a little variation of their position, in order to prevent the skin from being hurt by their pressure."

Cupping by which blood is abstracted is used either where general bleeding is unnecessary, or as supplementary to it, for the removal of congestions or local affections. It is analogous to the use of leeches, over which, however, when the situation of the part admits of the application of the glasses, it has in general many advantages. The blood is more rapidly abstracted, a point of great importance in inflammatory diseases; there is less risk of subsequent bleeding from the wounds; and the part of the body subjected to the operation is exposed to the air for a much shorter time. Cupping is also preferable in cases where the application of leeches is apt to be followed by severe erysipelas of the skin.

"In inflammations and congestions about the head, cupping on the back of the neck and between the shoulders is a most useful mode of abstracting blood; and this operation is also particularly applicable for the removal of blood from the parietes of the chest and abdomen in diseases of the different viscera. Its use, however, is only admissible when it can be employed without exciting pain, and irritating the diseased organ." Many cases of impending apoplexy may be warded off by the timely application of cupping-glasses to the neck, aided by a quickly-acting cathartic. Where the abstraction of blood is inexpedient or unnecessary, dry cupping is often resorted to with benefit. In adynamic states of fever, especially where the lungs are complicated in the diseased action, if "farther depletion cannot be ventured upon, dry cupping on the back or chest will sometimes be serviceable." (Copland's 'Dictionary of Medicine,' p. 930.) Dry cupping often affords great and immediate relief in many pains of the side, not inflammatory, but hysterical, which occur in females. The pains of the back which likewise occur in females at particular times may be much mitigated by dry cupping. The pains in the chest in consumptive patients are often quickly relieved by dry cupping,

Another and most important application of cupping is the prevention by its means of the absorption of poisonous fluids from wounds. For this purpose, anything by which a partial vacuum over the wounded part can be produced will answer, such as a wine-glass, tumbler, or teacup with a smooth margin, from which the air has been partially expelled by holding it for a moment over a lighted candle. This mode was in use among the ancients, has been revived among the moderns, and is practised by the South Americans in cases of the bites of venomous serpents, by means of a funnel-shaped calabash. The Greeks called a cupping instrument σικύα (sikua), from its bearing some resemblance to the form of a melon or gourd.

(Empson's *Narratives of South America*, p. 66; Wardrop *on Blood-letting*; Cooper's *Surgical Dictionary*.)

CUPRAMMONIUM. [COPPER.]

CUPRIC ACID. [COPPER.]

CUPROCYANOGEN. [CYANOGEN.]

CUPROHYDROCYANIC ACID. [CYANOGEN.]

CURACY; CURATE. [CLERGY.]

CURARA. [CURARINE.]

CURARINE. An alkaloid of unknown composition found in *curara*, the poisonous extract of the plant called *mavacure*, used by the South American Indians for poisoning their arrows. Curarine is obtained from curara by a tedious process which need not be here detailed. It presents the appearance of a yellow horny deliquescent mass, having a very bitter taste. It appears to form neutral salts with acids, but all those known are uncrystallisable. The most remarkable property of the curara, from which it is extracted, is that it may be taken into the alimentary canal of man or of animals with impunity, whilst a very small quantity introduced beneath the skin, rapidly produces fatal results.

CU'RATOR (from *curare;* that is, "to care," or "take care"), one who is appointed to take care of anything: in this general sense there were many kinds of curators.

In the civil law the word denotes one who is appointed to administer the estate of any person who is not legally competent to manage his property. 1. There was the curatorship (that is, guardianship) of minors (*cura minorum*). Every person who was *sui juris* (that is, not subject to paternal or domestic dominion, but who was still under age) was put under the superintendence of a guardian. But the Roman law distinguishes two kinds of guardianship; namely, tutelage (*tutela*) and curatorship (*curatela*). (Institutes of Justinian, i. 13.) The former kind of guardianship was in use if the minor was impubes; that is, if a male minor was not fourteen and a female not twelve years old. The guardian in this case was called tutor, and the minor, pupillus. After the tutelage was ended, in order to give some legal protection to those who, owing to youth and inexperience, might be overreached, without interfering with the old principle of full legal capacity being attained at the age of puberty, a law (Lex Plætoria) of uncertain date was passed, dividing citizens into two classes, those above and those below twenty-five years of age, for the purpose of protecting minors against fraud, by enabling them to receive curators till they attained twenty-five years. This distinction had some important consequences in the civil law, which have only recently fallen into disuse even in countries where the Roman law is still in force,—a distinction which Savigny has seized with his practised eye and explained with his usual clearness and ability. The maxim of the Romans, "personæ non rei vel causæ tutor datur" (D. 26, 26, 14), is the key to the whole system of Roman tutelage. The persona is the legal personal capacity of the ward, his capacity for formal transactions. The tutor's principal duty was to render this capacity complete (which is the meaning of the passage), and therefore his functions extended necessarily over the whole property of the ward, whose incapacity to contract or to enter into any kind of business was supplied by the tutor's direct personal intervention (auctoritas). The distinctive and important function of the Roman tutor, therefore, was to do what the ward could not legally do for himself, and what a *mere representative* could not do for him; namely, transact mancipations, stipulations, and other such forms. Hence we obtain the precise difference between the tutor and the curator,—that the former was the legal alter ego of the pupil or minor; the latter the mere representative of the ward, the ordinary administrator of his rights; and, therefore, in the maxim "per extraneam personam nihil adquiri (ne que alienari) posse," I. 2. 9. 5. the difference between the tutor and the curator is distinctly aimed at. (See 'The Vocation of our Age for Legislation,' by Von Savigny, trans. by A. Hayward,' p. 121) According to the strictness of law, the curatorship terminated with the twenty-fifth year of the minor; but it could also be determined by a solemn declaration of the emperor that the minor should be of age. (C. 2, tit. 45, de iis qui veniam ætatis.) This was called receiving veniam ætatis, and it could take place in the case of males in their twentieth, and females in their eighteenth year. 2. As spendthrifts and deaf and dumb persons could not legally administer their estates, they also were put under the superintendence of a curator. 3. A third kind of curator was the curator bonorum; that is, a trustee for the administration of the estate of absent or deceased persons and insolvent debtors. Between this curatorship and that of a minor there was this important difference; the latter was regarded as a public office, which could not be refused, except for such reasons as the law allowed; whilst between tutela and curatela this distinction deserves notice, that the duties of the tutor related to the person of the pupil, those of the curator to the property.

(Gaius, i. §§ 197–200; Just., 1, 23–26; D. 26, 3–10, and 27; and 5, 31–75; 'Ulp. Frag.,' tit. 11 & 12; 'Warnkönig Institutiones,' lib. i. ch. 4, §§ 238–265; 'Muhlenbruch Doctrina Pandectarum,' vol. iii., ch. 3, §§ 576–608; and 'Dictionary of Greek and Roman Antiquities,' article 'Curator.')

Curators in ancient Rome were also public officers of various kinds, particularly after the time of Augustus, who established several officers with this title. (Suet., 'Vit. Aug.,' cap. 37.) 1. Curatores viarum; that is, curators who superintended the laying out and repairing of the public roads. This office existed under the republic, but it was only held as an extraordinary one, and was conferred for special purposes. 2. Curatores operum publicorum, aquarum, cloacarum, who had the superintendence of the public buildings, theatres, bridges, aqueducts, and cloacæ. 3. Curatores alvei Tiberis, who were the conservators of the Tiber. 4. Curatores frumenti populo dividundi, whose duty was to distribute corn among the people. Under the emperors we find other officers with the name of curatores; as, for instance, the curatores ludorum, who had the superintendence of the public amusements; and curatores reipublicæ, also called logistæ, whose duty it was to administer the landed property of municipia.

CURCUMA LONGA, *Medical Properties of.* This perennial plant, belonging to the tribe *Zingiberaceæ*, is not ascertained to be native of any particular country in the East; it is occasionally wild, and it is also extensively cultivated in China, Java, Malacca, and in Bengal, prospering in a moist but not swampy soil. The mode of culture is described under CURCUMA, in NAT. HIST. DIV. The Chinese sort is most esteemed, rather on account of its superior richness in colouring matter than from any other cause. Two varieties are found in commerce, the round turmeric (*Curcuma rotunda*) and long turmeric (*C. longa*). These are generally regarded as the produce of the same plant; but even were they yielded by two, it is altogether incorrect to assign the round to *Curcuma rotunda*, Linn., which is the *Kæmpferia ovata*, Roscoe, a rare plant, the root of which is destitute of any colouring principle. The name is derived from the Persian kurkum, which means saffron; hence it is termed Saffran des Indes, but must not be confounded with common saffron, from *Crocus sativus*. It is likewise called by the French *Terra merita* (Curcuma, hæc Gallis Terra merita male dicitur), see Royle, 'Antiquity of Hindoo Medicine,' p. 87. The rhizoma or rootstock alone contains the aromatic and colouring principles, as the tubers common in this and other scitamineous plants, are devoid of both, and yield much of the East Indian arrow-root, being one of the kinds called by the natives Tikor. *Curcuma zedoaria*, Roxb., yields zedoary, which resembles turmeric.

Round turmeric occurs in knobs, roundish, ovate, or oval, sometimes pointed, and insensibly running into the long turmeric, and is of a deeper, more camboge-like colour in the interior. The pieces are from one to two inches long, and nearly one in diameter. The long turmeric occurs in pieces about two inches long, either straight, or curved, and doubled up, presenting on the surface more marks whence the root-fibres have sprung. The colour externally is of a brownish yellow, internally lighter than that of the round sort. The fracture has a waxy appearance, and the odour is unctuous. The taste is bitterish, aromatic, and like ginger, but less potent. "In the fresh state it has a rather unpleasant smell, somewhat resembling cerate, which goes off a good deal on drying."—Ainslie's 'Mat. Indica.' This article is very liable to be eaten by small beetles. Old, worm-eaten specimens should be rejected. Hard compact pieces, which with difficulty can be powdered, are best. It has been analysed by John, and subsequently by Vogel and Pelletier:—

John's Analysis.		Vogel and Pelletier's.
Yellow volatile oil	1	Acrid volatile oil.
Curcumin	10 to 11	Curcumin.
Yellow extractive	11 to 12	Brown colouring matter.
Gum	14	Gum (a little).
Woody fibre	57	Starch.
Water and loss	7 to 5	Woody fibre.
		Chloride of calcium.
Turmeric	100	

The colouring matter is given out very freely to water, and alcohol,

	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	N.	O.	P.	Q.	R.	S.	T.	U.
Turmeric	4oz.	2oz.	3oz.	5oz.	6oz.	2oz.	8oz.	6oz.	8oz.	3oz.	2oz.	8oz.	6oz.	4lb.	3oz.	8oz.	2½oz.	8oz.	3oz.	4oz.	2oz.
Coriander Seeds	8	6	1	3	1	1	2	13	2	4	2	16	6	4	6½	4	1½	2	12	13	6
Ginger	3	½	1	1	1	2	2	..	..	2	2	..	..	1	1	..	½	2	..	2dr	..
Cinnamon	½	2dr.	..	..	¼	..	..	..	½	..	..	..	..	..	1½	..	..	..	..	..	..
Cassia	..	..	..	..	..	..	..	..	2	..	..	..	..	2oz.	..	..	..	..	2dr.	2	..
Cardamoms	½	..	1	1	..	½	1	..	..	2	½	..	..	4	..	..	½	..	½oz.	2	..
Grains of Paradise	..	..	..	..	..	..	..	..	1	..	..	..	2	..	..	..	..	..	..	..	..
Chillies	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Caraways	..	..	..	..	..	..	..	..	..	..	..	..	4	..	..	..	..	..	..	..	..
Cayenne	..	6	¾	1	½	½	1	1	½	2	½	1½	½	1lb.	½	¼	½	1	6dr.	½oz.	½
Black Pepper	1½	½oz.	..	1	4	..	2	2	1	1	..	1½	1	..	2½	..	½	..	2oz.	2	3
Mace	..	1dr.	..	¼	..	..	..	..	2dr.	..	..	..	..	1oz.	..	..	½	..	..	..	..
Fœnugreek	..	1½oz.	½	..	1	..	..	..	..	..	..	2	..	..	1	2	..	1	1	..	1
Cummin	2	..	½	..	1	½	2	3	..	..	½	..	..	..	..	2	..	1	4	3	2
Pimento	..	2dr.	..	..	..	..	..	..	..	..	..	..	..	1lb.	1	..	..	..	2dr.	2dr.	..
Cloves	..	1	..	..	..	..	..	..	½oz.	..	..	..	..	1oz.	2dr.	..	..	½	2	2	..
Nutmeg	..	½oz.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
White Pepper	..	..	1	..	..	1	..	..	..	..	1	..	..	..	..	..	..	1	..	..	..
Scorched Mustard	..	..	..	2	..	..	..	..	..	3	..	..	..	..	..	..	1	..	..	..	..
Lemon Peel, in powder	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..

but curcumin in a pure state can only be obtained by digesting the alcoholic extract of turmeric in ether, and evaporating the etherial tincture to dryness. Its appearance in the mass is brownish-yellow, but when powdered, a full yellow. It is tasteless, odourless, almost insoluble in water, but readily soluble in alcohol and ether. The alkalies colour it a reddish-brown, and readily dissolve it. The alcoholic solution evaporated with boracic acid becomes red. Hydrochloric acid also reddens it. The alcoholic solution of curcumin produces coloured precipitates, with several salts, such as acetate of lead and nitrate of silver (Pereira). The frequent use of turmeric as a test renders a knowledge of these points necessary. (See Fresenius, 'Chemical Analysis,' by Bullock, p. 31.)

Turmeric has aromatic qualities which render it useful in languid habits, where digestion is difficult, and the circulation slow. The repute it enjoyed as a cure for jaundice and dropsies was founded on the doctrine of signatures (Cullen, 'Mat. Med.,' i. p. 25). It is of some importance as a dye, but it is as a condiment, both in the East and in this country, that it merits notice, as it is an ingredient in all curry powders and *curry pastes*. When in excess the colour is too brown, and one flavour predominates, which is contrary to sound apician law. The same observation applies to Cayenne pepper. "With us, turmeric and Cayenne pepper prevail in them far too powerfully."—Acton's 'Modern Cookery,' p. 227. The preceding table, extracted from the 'Pharmaceutical Journal,' vol. iv. p. 364, supplies an infinite variety of receipts for preparing curry powder, But whichever is preferred should have added to it some *mushroom-powder*. The meat, fish, or whatever article is employed as the basis of the curry should always be so perfectly boiled that it can be eaten with a spoon. This necessarily destroys the natural flavour of the meat. The mushroom-powder contains *osmazome*, the source of flavour in meat, and consequently it restores what the long cooking has dissipated. The curry-powder should not be added to the dish till a few minutes before it is to be served to table.

In the East, ready mixed ingredients are carried about from place to place, forming extensive articles of commerce, under the name of curry-stuff. These differ, according to the localities and taste of the natives; but whatever be the basis of a curry, the superiority of Indian to European curries, is the addition of *fresh acid vegetables*. It was a great error therefore in M. Soyer, in his 'Modern Housewife' to enjoin sugar as an ingredient. The Ceylon curry-stuff consists of "a piece of green ginger, two cloves of garlic, a few coriander and cummin fruits (seeds commonly), six small onions, one dry chili or capsicum, six or eight corns of pepper, a small piece of turmeric, half a dessert spoonful of butter, half a cocoa-nut, and half a lime." Simmonds', 'Dictionary of Trade Products.'

CURCUMIN. A resinous colouring matter found in turmeric-root. The root is first exhausted with boiling water: boiling alcohol then dissolves curcumin from the residue. It may be further purified by solution in ether.

Curcumin is amorphous, nearly insoluble in water, but very soluble in alcohol and ether. It is bleached by exposure to the sun's rays. It readily dissolves in alkalies with a deep red-brown colour. Hence the use of papers imbued with turmeric (turmeric papers) for the detection of an alkaline re-action. Curcumin consists of

Carbon	68·59
Hydrogen	7·54
Oxygen	23·87
	100·00

CURDS AND WHEY. [CASEIN.]

CURFEW. The custom of covering up their fires about sun-set in summer, and about eight or nine at night in winter, at the ringing of bell called the *couvre feu*, or curfew bell, is supposed to have been introduced by William I., and to have been imposed upon the English, as a badge of servitude. But the custom appears to have prevailed throughout Europe prior to this period; and was intended as a precaution against fires, which were then very frequent and destructive, so many houses being built of wood. Henry I. appears to have restored the use of lamps and candles at court in the night after the ringing of the curfew bell, which had been prohibited by his predecessors. (Will. Malmesb. fol. 88.)

Although spoken of by modern writers as a tyrannical custom, we find the curfew mentioned to a late period as a common and approved regulation. Among the charges directed for the wardmote inquests in London, in the mayoralty of Sir Henry Colet, in 1495, it is said, "Also yf there be anye paryshe clerke that ryngeth curfewe after the curfewe be ronge at Bowe Chyrche, or St. Bryde's Church, or St. Gyles-without-Cripelgate, all such to be presented" (Knight's 'Life of Dean Colet.') The same charge remained in the wardmote inquest, as printed in 1649. Hutchins, in his 'History of Dorsetshire,' vol. ii., speaking of Mapouder church, in that county, mentions land given "to find a man to ring the morning and curfew bell throughout the year." In the same volume, under Ibberton, is mentioned an acre given for ringing the eight o'clock bell, and 4*l*. for ringing the morning bell. At Barking, in Essex, the tower of the fire-bell or curfew still stands, and bears the name, though no longer used for its pristine purpose. Bishop Hall, in his 'Virgidemiarum,' printed in 1599 (b. iii. sat. 4), speaks of the gift of a new rope to ring the curfew bell as of occasional occurrence in his time:—

> "Whoever gives a paire of velvet shoes
> To the Holy Rood, or liberally allowes
> But a new rope to ring the curfew bell,
> But he desires that his great deed may dwell,
> Or graven in the chancel window glasse,
> Or in the lasting tombe of plated brass."

The curfew bell, strictly as such, had probably fallen into disuse previous to the time of Shakspere, who in 'Romeo and Juliet' applies the term to the morning bell:—

> "The second cock hath crow'd,
> The curfew bell has rung, 'tis three o'clock."

In the 'Antiquarian Repertory,' old edit., vol. i., is an engraving of an iron implement which is called a curfew, or cover-fire, formerly belonging to Gostling, the historian of Canterbury, and presumed to be of very ancient if not of Norman origin, but which in reality is no more than an *ex tempore* oven, lately if not still used in many parts of England for baking small viands: the hearth is first heated, the viand placed upon it, and then covered with this implement, the embers being raked round and above it. The practice of ringing the church bell at eight o'clock in the evening is still continued in many parts of England; and in many places where it is no longer rung, it has only been discontinued within memory.

CURIA. [COMITIA.]

CURRANTS. The fruit of the various species of *Ribes* (for the botanical account of which, see RIBES, in NAT. HIST. DIV.) has been used in medicine to allay thirst, and it is said to lessen the secretion of bile. The juice of the red currant is sometimes employed in making punch, and mixed with water forms the *eau de groseilles* of the French. It is also made into a jelly, and the berries are used for making tarts and puddings. When ripe the fruit makes an excellent wine, which is much used in the rural districts of England. The juice of the black currant is even more generally employed for making jelly, and the fruit is likewise used for tarts and puddings, and wine.

All the sorts are hardy plants, growing freely and bearing a plentiful crop of fruit. They thrive almost as well in one situation as another, whether it be open or shady, free or confined. This permits of the ripening of the fruit throughout a long period, so that it may be obtained as early as June and as late as October. Common garden soil is suited to them, which should be tilled and recruited from time to time with fresh manure. The largest crops are produced in a strong loam or improved clay soil. They are earlier in a light soil. Previous to planting, the soil should be dug two feet deep, and this may be done at any time from October to February or March. They are chiefly propagated by cuttings obtained early in the spring. These should consist of the previous year's shoots taken from bearing-branches, and be from ten inches to a foot in length. They should be planted 4 or 5 inches deep and may be watered in spring. In the summer all the shoots or buds should be removed except three. In the following autumn they may be transplanted. Currant bushes are best planted by themselves, and the distance between the rows should not be less than from 7 to 9 feet. They will grow freely against a wall, and when thus planted with a south or south-west aspect will produce ripe fruit three weeks earlier than standards with a north or north-east aspect: fruit may be preserved good till October, and if matted, as late as November. Grown on espalier rails the fruit is produced in the finest order.

The fruit of the currant should be gathered in dry weather, as when gathered in rain it loses its flavour.

CURRENCY. In this article it is proposed to present some of the fundamental principles of this great subject, a full inquiry into which is beyond the scope and objects of our undertaking. The term currency is used to express the circulating medium of exchange, by means of which sales and purchases are effected without the necessity of a recourse to barter. Various contrivances have been adopted at different periods of the civilisation of nations for this purpose: stamped pieces of leather passed as money among the ancient Lacedæmonians *corium formâ publicâ percussum* (Seneca, 'De Benef.' lib. v. cap. 14) and Carthaginians. Salt in lumps was used as money among the Abyssinians (Smith, 'Wealth of Nat.' b. i. cap. 4). The shells called cowries constitute the received currency in parts of Hindostan and the interior of Africa. When the Spaniards first visited Mexico, the natives, it is said, used cocoa nuts as the medium of exchange. Tobacco made up in bars or rolls, in Virginia and some other states of North America, in the early periods of their settlement, were made legal tender by law (Tatham 'Histor. Essay on Tobacco'). But there are obvious objections to each of these or similar materials of a currency, either from bulk, weight, want of invariability of value, want of durability, or some other requisite to a convenient medium of circulation. These reasons have driven all civilised nations to the employment of gold and silver, coined into pieces of different values, as the basis of their current money. [BULLION.] But as population increases, and the wants of men multiply, and the movement of commerce becomes more rapid and oftener repeated, the quantity of gold and silver money requisite for carrying on the increasing number of the operations of trade and business increases, and the cost of such a currency becomes enormously magnified: and hence arises a difficulty which has given birth to one of the most refined of all the expedients for facilitating intercourse which the necessities of society have generated. Paper money is the result: whereby in the larger transactions of business an acknowledgment of a debt or a promise to pay, expressed in writing, by an individual or body of individuals, passes from hand to hand as money, the circulation of such paper depending, in the first instance, on the credit of the person who acknowledges his liability or pledges his promise, and subsequently on the credit, in addition, of those who successively receive and pay the instrument as though it were really worth so much money as it purports to be worth. By this means, therefore, a large addition may be made to the circulating medium of a country, at a small expense, as compared to the expense of providing the same amount of metallic money. In fact, a paper currency substitutes credit for coin. In France, the currency is wholly metallic, consisting of gold, silver, and copper. Their gold and silver currency has been estimated as of the value of 2200 to 2500 millions of francs: the maintaining of which (supposing the usual rate of profit to be 6 per cent. per annum, or that the money, if not employed in the coinage but employed in business, would have, in ordinary times, fetched that profit) would yearly cost the public exchequer 132 millions of francs, without calculating wear and tear and loss. With these and other additional expenses depending on casualties, it may fairly be inferred that the cost, to the nation, of the gold and silver portion of the currency of France is not much less than six million pounds sterling a year. In this country, the national currency is partly metallic and partly of paper; the latter being divisible into inconvertible paper money and convertible paper money. The former consists of the bank-notes of the Bank of England, which practically may be said to circulate as money *per se*, because they constitute a legal tender, that is, they must be accepted in payment of debts, and payment in gold or silver is only demandable for them at the Bank of England or its branches. [BANKING.] The convertible paper money consists of the bank-notes of private bankers and banking copartnerships, which are payable in gold or Bank of England notes on demand at the respective banks. These a creditor cannot be obliged to receive in payment of a debt due to him. The peril of an inconvertible paper currency is, lest those in whose hands is the power of issuing it should be tempted to overdo the quantity of paper sent into circulation, a proceeding the results of which are most disastrous. An instance will show this: Suppose Jones gives Thompson his bill of exchange for 360*l.* at 3 months, in payment for 120 quarters of wheat at 3*l.* a quarter, and at the end of three months pays Thompson 360*l.* in bank-notes. But suppose that, in consequence of an over issue of bank paper beyond what is duly required for the necessary circulation, wheat in the meantime has risen to 4*l.* a quarter; then Thompson can only buy 90 quarters with his 360*l.*, and is in the same condition as if he had in the course of the three months lost or been robbed of 30 quarters. This shows why uniformity is one qualification of a proper currency, in fact an essential; it shows how those who sell on credit must be prejudiced if, between the date of the contract and the day on which the credit expires, the price is altered by a fluctuation in the medium of exchange. The landlord is also in the same position, though in this case the result is not susceptible of being shown with the same clearness: but in this case also, increased abundance of money taking place between the date at which the terms of a lease are settled, and the expiration of it, are prejudicial to him and favourable to the tenant: on the other hand, a diminution in the circulating medium has in general a tendency to produce a fall of prices. One of the great problems of the currency in this country is, "What is an issue of currency in excess?" It has commonly been granted that the payment by Government of the sums, owing by them on account of the state, in inconvertible bank paper may cause an over issue, so that the value of such paper may become depreciated by such excess. The case of the *assignats* in France, in the time of the Republic, is in point. They were practically inconvertible, they were over-issued, and became vastly depreciated. But whether the bank-notes which are issued by the Bank of England, in the discount of bills of exchange presented to them in the course of business, can be issued in excess, so as to be depreciated, has been much contested. These issues, it is urged, are nothing but a compliance with the legitimate demands of the public for circulating medium; the supply of notes in such case is necessarily exactly limited by the demand, and by the amount of security which can be provided by those who require the accommodation: and therefore, it is said, there can be no excess, and so no depreciation. In truth, however, there is no tangible limit to the public demand for ready money, and therefore the above considerations have not been deemed in general to be conclusive, nor do the best authorities consider that there is any difference, in respect of over-issue and depreciation, between the two modes of adding to the currency above-mentioned. What then is the result of any over-issue of paper money in this country, so that the whole currency becomes larger than the wants of trade or the necessity of an adequate medium of exchange require? The over-issue is corrected in this way: As soon as the over-issue depreciates the whole currency by more than 1, or from 1 to 2 per cent., then as gold is everywhere in demand, and the expense of the transmission of it seldom exceeds from 1 to 2 per cent., the foreign exchanges will become unfavourable to this country, and gold will begin to be worth exporting, and will be exported, and the issuers of paper must withdraw their superfluous issue as quickly as they can, in order to restore the equilibrium of the currency. That over-issues may depreciate the currency, at least the paper portion of it, is manifest from the circumstance that in 1814 bank paper was at a discount as compared with gold of not less than 25 per cent. So a metallic currency may be depreciated by wear and tear. Thus, previously to the great recoinage of the silver currency under Mr. Montague, then chancellor of the exchequer, in the reign of William III. (begun in 1696), the silver in circulation was so much worn, &c., that the golden guinea passed current at from 28*s.* to 30*s.* (Earl of Liverpool on Coins.)

It will be observed that amongst the various descriptions of paper currency we have not included bills of exchange, cheques, and promissory notes of merchants, &c., an immense value of which is constantly passing from hand to hand, and operating in some respects as money; and the reason why these kinds of paper are not included is that there are substantial and material differences between these and the former characters of paper, such as the following: a bank note purports to be payable on demand; passes by delivery without indorsement, the party receiving it has practically and in general no claim on the party from whom he received it as payment. (See Grant, on 'Banking,' pp. 408-412.) Bills of exchange, &c., are mostly drawn payable at a day to come; every one whose hands the bill passes through must indorse it if he wishes to pay it away, and by so doing makes himself liable in respect of it for the ultimate payment of the sum mentioned in it. The circulation of a bill depends chiefly on the confidence felt by the receiver of it in the last indorser, his own correspondent in trade. The circulation of a bank note is due rather to the circumstance of the character and responsibility of the party issuing the note being well known to the receiver, or being a person or house of generally established credit. In this country the law as well as the practice and opinion of merchants and political economists make the same distinction. (Chitty on 'Bills,' pp. 1, 2, 3.) It is observable also that bills of exchange no where form the circulation of any place or district, though they may each for the time it has to run, and for the amount it stands for, have circulated amongst the persons whose names appear upon the back of it as indorsers, generally but a small number of persons; therefore bills of exchange and promissory notes of merchants, do not seem to be money, and are not usually (though some authorities are of a different opinion) considered as forming parts of the currency. Some persons hold that not only bills of exchange and promissory notes, but cheques and drafts on bankers, and even money deposited with bankers, are to be considered as part of the currency; but the grounds on which this theory is attempted to be supported, have met with but little adherence. ('Evid. before Committee of H. of Com. on Bank Acts of 1858,' Q. 932, 933.)

The average circulation of Bank of England notes required for the purposes of business in England and Wales—in Scotland Bank of England notes pass but to an exceedingly limited extent—is from 19,000,000*l.* to 20,000,000*l.* This amount varies at different times; it has been as high as 23,000,000*l.*, and as low as 17,000,000*l.* ('Evidence before Committee of H. of Com. on Bank Acts of 1858,' Q. 657, 660, 674, 677, 947, 950.) Yet the proportion is small which the Bank of England notes perform in the function of circulation, and the liquidation of debts and payments throughout the country. (*Idem.* Q. 2411, 2414, 2394, 2771.)

There has been a remarkable variation in the quantity and in the denomination of the Bank of England notes required for the uses of the public as currency of late years. Notwithstanding the great increase of population, and the acceleration of trading transactions which have taken place since 1844, the whole amount of Bank of England notes has actually diminished, and still continues to decline. But the 5*l.* and 10*l.* notes in circulation, which in 1851 were 9,362,000*l.*, had risen in 1856 to 10,680,000*l.*; the notes for 200*l.* to 1000*l.* had decreased from 5,856,000*l.* in 1852, to 3,241,000*l.* in 1857. (Report of same Committee, pp. iv., v.)

There is no means of learning what is the amount of gold, silver, and copper coin in circulation at any given period; because the amount is always liable to fluctuations, sometimes by reason of the exportation of sovereigns when the price of gold on the Continent makes it profitable to export; at other times, by the fresh quantities of sovereigns put into circulation owing to fresh importations of gold dust or bullion and other causes.

We will conclude this article by stating that the object of the existing law, with reference to the currency of this country, is to render the present mixed currency of metallic money and paper variable according to the rules by which a purely metallic currency would vary; and for further details and illustrations of this very difficult subject, the reader is referred to the Report and Evidence above cited, as containing the latest and fullest body of authorities.

CURRENTS. [TIDAL WATERS.]

CURRY POWDERS AND CURRY PASTES. [CURCUMA LONGA.]

CURRYING. [LEATHER.]

CURSITOR BARON, an officer of the Court of Exchequer, formerly appointed by patent to be one of the barons of the Exchequer. His duty, before the abolition of the office, was to attend at Westminster to open the court prior to, and after each term, to close it. Prior to 1833 he had various other duties to perform; but since the act 3 & 4

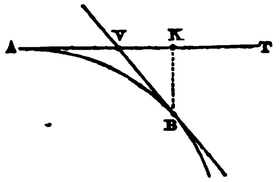
Will. IV. c. 99, much of the business of his office has entirely ceased; and the commissioners appointed under the 1 Will. IV. c. 58, having recommended the abolition of the office, this was recently effected on the death of the last Cursitor baron, 19 & 20 Vict. c. 86.

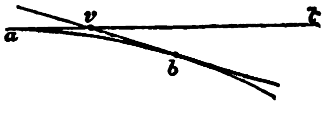
CURTATE (shortened), a term sometimes applied in geometry or astronomy to a line projected orthographically upon a plane. [PROJECTION.]

CURTEIN, or CURTANA, the name given to the first or pointless sword, carried before the kings of England at their coronation; also called the sword of King Edward the Confessor. It is mentioned by both these names in Matthew Paris, under the year 1236, when detailing the marriage ceremonial of Henry III. In ancient times it was the privilege of the earls of Chester to bear this sword before the king, which, in an emblematical form, is considered as the sword of mercy.

CURVATURE, a mathematical term expressive of the comparative degree of bending which takes place near the different points of a curve. If we imagine a point to describe a curve, that is, to be continually changing the direction of its motion, it may change this direction either more or less rapidly, that is, describe a line which is more or less curved. As in the article CONTACT, we shall first take a rough method of illustration grounded on the notions we derive from experience, and show how the accuracy of mathematics is introduced into the definition. We must suppose the reader to have gained the ideas which are introduced in the articles DIRECTION and VELOCITY.

Two points, A and *a*, are describing two curves, the directions of motion at A and *a* being AT and *a t*. That the first curve is more curved than the second, we may easily see; and if we wished to give some notion of the comparative degree of curvature, we might proceed as follows: Measure off equal arcs AB and *a b* (remember this equality throughout), say of one inch each; ascertain the directions BV and *b v*, in which A and *a* are proceeding when they arrive at B and *b*, and measure the angles BVT and *b v t*. If we find the first to be twice as great as the second, then the phenomenon by which we recognise curvature (change of direction) is twice as rapid in the first as in the second. Hence we say that the curvature of the first is twice as great as that of the second.





But here arises a difficulty of the same kind as that explained in VELOCITY. The preceding ratio of two to one is that of the whole effects of curvature from A to B, and from *a* to *b*. If the change of direction were uniform, that is, if every tenth (or other) part of AB gave a tenth (or similar other) part of the change of direction, it would then be indifferent whether we chose an inch for AB and *a b*, or any other length. But if the curvature do not continue uniform, the comparison of the united effects of all the curvatures from A to B, and from *a* to *b*, does not give a proper ratio of the comparative curvatures at A and *a*. The only curve in which this is the case is the circle, which is the curve of uniform curvature, just as the straight line is the line of uniform direction. But we immediately perceive that if AB and *a b* had each been the hundredth part of an inch instead of an inch, this objection would have held in a less degree; if the thousandth part of an inch, still less, and so on. Hence, as in VELOCITY, it is not by the proportion of the angles BVT and *b v t* that we get an exact and unalterable notion of what is taking place at A and *a*, but by the limit to which that proportion approaches, as B and *b* move back towards A and *a*, and the angles in question diminish without limit. This is the accurate terminal notion on which the mathematical theory of curvature is founded.

If the two curves had been circles (or curves of uniform curvature) it is found that the limit of the proportion of these angles (or the proportion of the angles themselves, which for circles is the same as its limit) is inversely as the radii of the circles; that is, doubling the radius of a circle halves its curvature, and so on. This suggests an absolute measure of the curvature at A. Let the second curve be a circle, so taken that BVT and *b v t* shall have a limiting proportion of 1 to 1, or shall continually approximate to equality. The circle *a b* has then at *a* the same curvature as the curve at A, and its radius (called the radius of curvature) being determined, the degree of curvature at A is known, as compared with that of any point of any other curve whose radius of curvature is known. This radius of curvature is thus determined: Draw the perpendicular BK and the chord AB. Then if the chord AB be always represented by the fraction *c* of an inch, and BK by *k* of an inch, the limit towards which $c \times c \div k$ approaches, as B is made to approach towards A, is the diameter of the circle of the curvature, or double of its radius. Or if through A and B a circle be always conceived to pass, which touches AV at A, the limiting position of that circle is the circle of curvature.

If the curve be referred to rectangular co-ordinates, and if x and y be those of the point A, $y = \phi x$ the equation of the curve, and ϕ' and ϕ'' the first and second differential co-efficients of ϕx, then

$$\text{Radius of curvature at A is } \frac{(1+\phi'^2)^{\frac{3}{2}}}{\phi''}$$

If ϕ be the angle made by the tangent with the axis of x, and s the arc from any given point to A,

$$\text{Rad. of curv. at A is } \frac{ds}{d\phi}$$

When the curve is not a plane curve, imagine it orthographically projected upon a plane. Its change of direction is then partly parallel to the plane, partly perpendicular to it, and the curve is said to have *double* curvature. But as this subject, together with that of the curvature of surfaces, is not of an elementary character, we shall not proceed further here, but refer to works which treat largely of the Differential Calculus.

The circle of curvature is also the circle of contact, or the nearest circle which can be drawn to the curve, just as the straight line of direction is also the line of contact, or the tangent. An infinite number of circles can be made to present the appearance of touching the curve at A [CONTACT], of all of which the circle of curvature comes the closest. Moreover, it always cuts the curve which it also touches (in the mathematical sense), except only at particular points; that is to say, the circle of curvature has in general a contact of the second order with its curve, in which case the circle always passes through the curve. But if at any particular point the contact should be of a higher and odd order, the circle of curvature does not pass through the curve.

CURVE, and CURVES, THEORY OF. A curve is a line which has *curvature*. Though the second of these terms be derived from the first, yet it is the notion explained in the preceding article which is preliminary to the explanation of the general term *curve*. Let a point move with a perfectly gradual change of direction, and it describes a curve.

Curves are said to be of the same species, in which the motion of the describing point is regulated by the same mathematical law. Thus the general law of the circle is, that all its points are equidistant from a given point. This law is the characteristic of the species; one circle is distinguished from another by the length of the constant distance supposed in the law of formation.

And in like manner as 0, or nothing, is classed under the general name of number or quantity, so the straight line itself (or the line without curvature) is, in algebra, spoken of under the general term *curve*. Or, in the last-mentioned science, the word means any line which is described by a point moving under one and the same law through every part of space which is consistent with the law.

The connexion of algebra with the doctrine of curves depends upon the method of co-ordinates (ABSCISSA, ORDINATE, CO-ORDINATES), by means of which every algebraical function whatsoever is connected with the properties of a curve. This is the point of greatest utility in the theory, namely, the power which it gives of representing to the eye all the varieties of magnitude which an algebraical function undergoes, while one of its letters passes through every state of numerical magnitude.

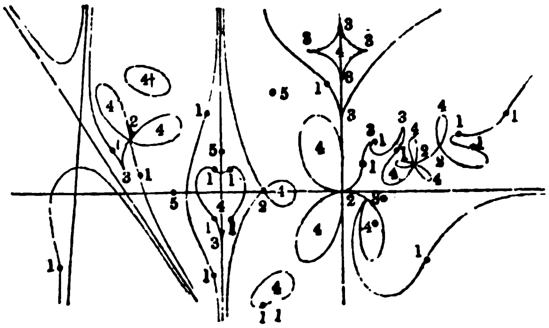
The number of curves which have received distinct names, out of the infinite number which may be drawn, is very small; we subjoin the names of those which are of most usual occurrence, referring to the several articles for further information, for the cases which are not presently mentioned.

1. Circle.
2. Ellipse.
3. Hyperbola.
4. Parabola.
5. Semi-Cubical Parabola.
6. Cissoid of Diocles.
7. Conchoid of Nicomedes.
8. Trisectrix.
9. Lemniscata.
10. Cycloid.
11. Companion of the Cycloid.
12. Harmonic Curve.
13. Trochoid.
14. Epicycloid and Cardioide.
15. Hypocycloid.
16. Epitrochoid.
17. Hypotrochoid.

Trochoidal Curves.

18. Curve of Sines, cosines, tangents, &c. [SINES, TANGENTS, &c., CURVES OF.]
19. Exponential or Logarithmic Curve.
20. Spiral of Archimedes.
21. Logarithmic Spiral or Equiangular Spiral.
22. Reciprocal Spiral.
23. Lituus.
24. Quadratrix of Dinostratus.
25. ——— of Tchirnhausen.
26. Catenary.
27. Tractory.
28. Syntractory.
29. Tractrix.
30. Ovals of Cassini.
31. Watt's Parallel motion curve.

The general characteristics of curves are extremely varied, and very few of them have received names. We subjoin a diagram, which will show all the varieties of figure most commonly considered in works on the Differential Calculus, premising, however, that we do not actually know any curve which contains them all. It would appear as if our figure contained several curves, but it must be remembered that in the algebraical sense many curves exist with branches completely unconnected, but all described under one law.



The several parts of the preceding are of continual occurrence; the following are the names and references:

(1). Points of inflexion or contrary flexure. [FLEXURE, CONTRARY.]

(2). MULTIPLE POINTS, double, triple, &c., according to the number of times the curve passes through them.

(3). CUSPS: the terms are hardly sufficiently well settled to enable us to say whether the 3* is to be considered a double point, a triple point, or not a multiple point at all.

(4). It is customary to call any part of the curve which encloses space an OVAL, though, according to the common meaning of the term, there is no oval in our diagram except 4†. Of 4* we hardly know whether it would be called an oval or not.

(5). Conjugate points [CONJUGATE]; when of a general law of description which gives ovals, a particular case is taken in which an oval disappears, it generally leaves behind it, so to speak, a single point which is included under the equation to the curve, but has no contiguous points. We should propose to call these points *evanescent ovals*. [INVOLUTE, EVOLUTE, CAUSTIC, CONTACT, TANGENT, ARC, AREA, ASYMPTOTE, MAXIMA and MINIMA, &c.]

Some remarks on a few of the curves in the preceding list of names are given here.

5. *Semicubical parabola.* The term *parabola* has been extended to mean any curve having an equation of the form $y=ax^m$, where m is positive. Thus $y=ax^3$ is the cubical parabola, and $y=ax^{\frac{3}{2}}$ is the semicubical parabola. The semicubical parabola is the evolute of the common parabola. The term *hyperbola* has been extended to any case in which m is negative.

8. *Trisectrix.* See this curve described in TRISECTION, and figured in TROCHOIDAL CURVES.

11 and 12. For the *Companion to the Cycloid*, see CYCLOID. The harmonic curve, so called because it, or a portion of it, is one of the simplest forms assumed by a vibrating string, has for its equation the relation between x and y implied in

$$x=a\theta \qquad y=b\,(1-\cos\theta).$$

12 to 17. These curves are all described in TROCHOIDAL CURVES.

20 to 24. See SPIRAL.

30. *Ovals of Cassini.* Dominic Cassini (see James Cassini's 'Astronomy,' vol. i. p. 149) proposed, as a better representation of the planetary motion than the ellipse, a curve in which the rectangle of the distances from any point in it to two fixed foci is constant. This curve is of the fourth order, and may be one oval, a lemniscate form, or two separate ovals, according to the ratio of the given rectangle to the square on the distance between the foci. It is hardly necessary to say that Cassini was wrong in his application of this curve: but the celebrity of his name has kept his oval or ovals among the curves which serve for exercise to beginners.

31. *Watt's Parallel Motion Curve.* The end of the beam of a steam-engine describes an arc of a circle; but it is required that the end of the piston-rod, which must be in some way attached to it, should describe a straight line, or a curve which is very nearly a straight line. Now at and near a point of contrary flexure the arc of a curve is very nearly straight. If two rods revolve round fixed pivots, their ends being connected by a third rod, the middle point of that third rod will describe a curve which has a point of contrary flexure; and if the lengths of the rods be properly taken, and if one of the rods be the beam of the steam-engine, the reciprocating rotatory motion of the beam may be made to communicate what is practically a reciprocating *rectilinear* (improperly called *parallel*) motion to the middle point of the third rod, on account of the arc described by that middle point containing the point of contrary flexure. A piston therefore may be attached to the middle point of the third rod, and the requisite condition is practically satisfied. The apparatus described in the article STEAM-ENGINE, and in Lardner's 'Steam-engine,' consists in the addition of a pair of rods which with the first and third compose a parallelogram moveable at all its joints. This is intended to furnish the same reciprocating rectilinear motion to a second piston placed at the new joint, which is nothing to our present purpose. Watt's parallel motion curve must be defined as the locus of the middle point of a straight line of given length, the ends of which describe arcs of circles.

The following considerations on the definition of the word *curve* will be useful to the young analyst:—

Geometrically speaking, a curve is described by a point which moves according to one uniform law, and does not describe a straight line. An oval, for instance, formed by arcs of circles in the manner described in books on mensuration, is not a curve, but a junction of several arcs of different curves: and even the two branches of an hyperbola cannot be said, in this primitive view of the subject, to be anything but two curves; accordingly they *were* called opposite hyperbolas.

But, algebraically speaking, the meaning of the word curve is much extended. Every curve, just defined, has one permanent equation connecting the abscissa and ordinate of every point in it. The converse is made true by extension of the definition of the word *curve*. All the points whose co-ordinates satisfy an equation constitute the curve to which the equation is said to belong. Let x and y be the abscissa and ordinate of a point; and $\phi(x, y)=0$, the equation which is to connect them. If this equation be satisfied when $x=a$ and $y=b$, the point whose co-ordinates are a and b is considered in every case as belonging to the *curve* whose equation is $\phi(x, y)=0$. The consequence is that a curve, or what is so called in algebra, may be either the simple curve of geometry—or a collection of such curves formed under algebraical modifications of one law—or a collection of such curves not even connected by one law—or an isolated point—or a collection of isolated points at finite distances from one another—or a collection of isolated points infinitely near to one another, but which nevertheless cannot be considered as forming one continuous branch of an ordinary curve. Or it may be any combination of two or more of these. We give some instances, as follows:—

1. The equation $y-m^2x^2=a^2$ belongs to both the branches of an hyperbola. If a change, m remaining constant, the hyperbola becomes a different hyperbola, with the same asymptotes as before. But if $a=0$, the equation belongs simply to those two asymptotes, that is, to two distinct and independent straight lines. In like manner the equation

$$(x^2+y^2)\,(x+y)=x^2+y^2+x+y-a$$

belongs to a complicated curve, with various branches. But if $a=1$, this curve resolves itself into two distinct curves, the straight line $x+y=1$, and the circle $x^2+y^2=1$. For the equation can then be reduced to

$$(x^2+y^2-1)\,(x+y-1)=0$$

which is satisfied whenever either $x^2+y^2-1=0$ or $x+y-1=0$ is satisfied. If a, instead of being $=1$, is only very near to 1, the curve approaches very near to the circle just mentioned throughout, and, except for great values of x, also to the straight line.

2. The equation

$$(x-a)^2+m(y-b)^2=0$$

belongs to a distinct pair of straight lines when m is negative. But when m is positive, it belongs to nothing but the point whose coordinates are a and b.

3. The equation

$$y = ax^2 + \sin x . x^{\frac{1}{2}}$$

belongs to a branch with an infinite number of intersecting convolutions, when x is positive: but when x is negative, it belongs to nothing but an infinite number of isolated points, situated at finite distances from each other on a parabola.

4. If $y=a^x$, a being positive, there is a continuous branch in which there is a positive ordinate for all values of x. There can be no negative ordinate except for values of x which have, when in their lowest terms, odd numerators and even denominators. But between any two values of x can be interposed an infinite number of such fractions. There is then a branch of the curve which, though it may be said to contain an infinite number of points, infinitely near together, cannot be called continuous. For there is no negative value of y when x is a fraction which has an even numerator and an odd denominator. These *pointed branches*, as they have been called, have only been recently considered. Their admission depends entirely upon definition. Those who would restrict the meaning of the word curve to something like its ancient signification, will reject them: but those who wish to look upon a curve as a tabulation in space of every possible value of x and y which will satisfy a given equation, must admit them. The few hints here given on the extension of the word curve are meant to excite the curiosity of those who have not been accustomed to look at geometrical interpretation as subordinate to algebra.

A distinction ought to be drawn between *algebraic geometry* and *geometrical algebra*. In algebraic geometry, in which algebra is brought to the assistance of geometry, the old notion of the meaning of *curve* might be retained. But in *geometrical algebra*, in which geometry is used in illustration of algebra, all the extensions which we have mentioned must be introduced. The use of this distinction would be, the elimination of disputes about words.

CUSCO-CHINA. There seems now no room to doubt that three different barks pass under this name: one, the produce of *Cinchona scrobiculata*, var. *α genuina*, called in Peru red Cusco bark. It approximates to the Calisaya bark: so much so that Guibourt has termed it *Calisaya léger;* but it differs from all the known cinchonas in the character of the alkaloid it contains. The second appears to be the produce of *Cinchona pubescens*, var. *α Pelletieriana*. This was the bark observed and described by Jobst (Buchner, 'Repert.,' xxxii. p. 464), and from which Pelletier procured the alkaloid which he called *Aricina*, by many used erroneously as a synonym for cusconia. A third kind passes by this name, which may probably be the white Jaen (Jen, corruptly), which Bergen assigns to the *C. pubescens.*

The alkaloid is procured by the same process as is used for cinchonia, which it resembles in its physical qualities, but differs in its chemical habitudes. The taste is more bitter, rather heating, and sub-astringent. It is equally insoluble in water, but easily soluble in alcohol and in sulphuric ether. It forms with acids salts which resemble those of cinchonia, but have a more bitter taste. The sulphate conducts itself singularly. A concentrated watery solution of this salt forms on cooling a tremulous jelly, which on drying becomes horny, but which, by the assistance of boiling water, resumes the jelly-like state. Cinchonia, quinia, and cusconia are supposed to be one base or radical with progressively increasing proportions of oxygen.

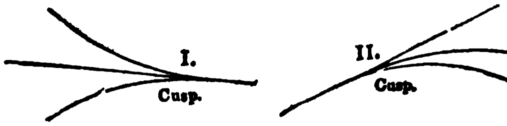
The formula of these is

$$(C_4H_{24}Az_2) + O \text{ cinchonia.}$$
$$(C_4H_{24}Az_2) + O_2 \text{ quinia.}$$
$$(C_4H_{24}Az_2) + O_3 \text{ cusconia.}$$

This composition renders it worthy in the highest degree of the attention of medical men. The warmth which it excites points out the propriety of giving it in cold intermittents, and low typhoid states of the system.

CUSP (Cuspis, a pointed end), a mathematical term used where two branches of the same or different curves appear to end in a point. Thus, in an eclipse of the sun, the borders of the sun and moon make two cusps at their point of intersection.

In the theory of curves, the cusps which appear are always such that the two branches have a common tangent at the cusp, and they are distinguished into the cases in which the tangent lies between the branches or on one side of both.



In the actual determination of the position of cusps by means of ordinates to a given axis, there are two distinct ways of proceeding.

1. For cusps whose tangent is perpendicular to the given axis.
2. For cusps whose tangent is not perpendicular to the axis.

The first case ought in part to fall under the theory of maxima and minima; ϕx being the ordinate, it is the case where $\phi' x$, the differential coefficient, becomes infinite and changes sign; or becomes infinite and afterwards impossible, having previously had two values of the same sign for each value of x. These cases give cusps of the first and second kinds, as shown in the two diagrams.

Many other cusps (namely, those whose tangents are oblique or parallel to the axis) are found by observing the points at which $\phi'' x$, the second differential coefficient, takes the form A, having previously had that of $A \pm B$; that is, in $\phi'' x$, the points must be found at which a term of double value vanishes and then becomes impossible. If for points immediately preceding, the $A + B$ and $A - B$ were of different signs, the cusp is of the first species; if of the same sign, of the second species. It would be useless to attempt separation of the theory of cusps from the general theory of curves, further than is contained by the preceding rules. There is no universal test by which they may be detected. The two species of cusps are said to be of the first and second kind, as marked. Few will remember which is the first and which is the second. It would be better to call them cusps of similar curvatures, and cusps of opposite curvatures.

CUSP, a term given by Sir James Hall, in his 'Essay on the Origin of Gothic Architecture,' and now commonly applied to the foliated points terminating the internal curves of the trefoiled, cinquefoiled, &c., heads of pointed arch windows. Cusps were originally introduced, both on the Continent and in England, in the later period of First Pointed architecture. In the earliest instances they were simple points or finished with a small leaf, and they sprung directly from the soffit or under-side of the arch. In what is known in England as Decorated Gothic, the cusps spring from the inner moulding of the arch, and are terminated with leaves, flowers, curls, &c. In the latest or Perpendicular style, cusps are sometimes very florid in style. The beauty of the tracery in a pointed window is largely due to its cusps.

CUSPARINE, an alkaloid found in the *Cuspara febrifuga*, and of which little is known.

CUSTOMARY FREEHOLDS. [COPYHOLD.]

CUSTOM-HOUSE. An office established in seaports, at which the customs-duties are collected from importers and exporters of customable commodities.

CUSTOMS, or USAGES, in law (consuetudines), are either general or local. The first kind consists of those usages which have prevailed throughout England from time immemorial, but, without their original institution having been handed down to us in records or writing, have been recognised by judicial decision,* and form that common law, or lex non scripta, which is the chief foundation of English jurisprudence. To like immemorial usage is to be ascribed the existence of such parts of the civil and canon laws, as from the earliest times have formed the rule in the king's ecclesiastical, military, and admiralty tribunals, and also in the courts of the two English universities. These laws of foreign origin subsist however only as inferior branches of the customary law, subject to the superintendence and control of their proceedings by the superior temporal courts, and to a strict observance of the rules of construction assigned by these last to the statute law.

These general customs of the realm, which form the common law, properly so called, alone warrant the existence and jurisdiction of the king's superior courts; and can only be drawn into question there. These general customs, as originally methodised by the Saxon kings, and in some cases modified in the early Norman reigns, supplied those fundamental rules by which, in cases not provided for by express enactment, the course of inheritances, the interpretation of acts of parliament, and most of the remedies for civil and criminal injuries are regulated. Numerous axioms essential to the administration of common justice have no other binding force than ancient and uninterrupted usage, which has obtained the force of law by the recognition of the courts. [COMMON LAW.]

Among these general customs must be enumerated those laws which govern the particular bodies of men to which they relate; merchants, innkeepers, carriers, owners of land adjoining the sea coast, &c., &c., as well as the inhabitants of particular counties or boroughs, in the particular instances of gavelkind and borough English. That custom called the law of the road, by which riders and drivers are expected to keep the left hand, as well as that respecting servants hired at yearly wages, by which either master or servant may determine the contract at a month's warning, or on paying a month's wages, have been recognised by the courts from time to time as parts of the common law. These, like the rest, originated in general convenience, and being gradually drawn more into notice by frequent recurrence, have been finally sanctioned by judicial authority. For immemorial customs may be extended to things and circumstances which arise at the present time. Thus a custom from time immemorial that all officers of a court of justice shall be exempt from serving other offices includes offices created within the time of legal memory, but cannot be enlarged beyond the extent to which the use has been carried; for that, and not the reason of the thing, determines the courts in declaring what the law is in such cases.

The customs by which the superior courts of Westminster Hall regulate their administration of justice, are popularly termed their practice. These rules are founded on ancient usage, and, in respect of their universality, form a part of the common law without its being necessary to allege custom or prescription to warrant them.

Where a custom is already part of the common law, the superior courts will take judicial notice of its existence as such, without requiring it to be stated in the written pleadings. Thus each of these tribunals will take judicial notice of its own customs or practice as well as of that of the rest; whereas the practice of inferior courts, as well as particular or local customs, extending to certain persons or districts only, being therefore different from and contrary to the common law, must, with the exception of gavelkind and borough English, be set forth with due precision.

This, though an observation apparently technical only, forms in its application the test by which we distinguish general from the local or particular customs just described. These latter customs must necessarily have had their origin in the peculiar wants of their respective districts, and are the remains of that multitude of similar usages from which Alfred and his Saxon successors collected those laws which may be considered as forming the common law of the nation at the time.

Many of these customs, for reasons now forgotten, were permitted to remain in some counties, cities, and manors, &c., in their former vigour, though at variance with the laws of the rest of the nation, and are confirmed by Magna Charta and other acts of parliament. Such are the customs of gavelkind (abolished in Wales by stat. Henry VIII.), by which all the sons inherit alike; of borough English, by which lands held in burgage tenure descend to the youngest, instead of the eldest son; and of some boroughs, that widows shall have dower of all, instead of a third of their husband's lands. A more striking instance is that of the custom in many cities and towns to hold courts for trial of causes without royal grant. The particular customs of manors as to descent, &c., are also of this kind, and bind the copyhold and customary tenants. The existence of every such local custom, with the exceptions above noticed, as well as its application in each particular case, must be alleged in the pleadings, and proved, like any other fact, before a jury: sometimes they are open to evidence without being pleaded. Under no circumstances could these questions be entertained by an ecclesiastical court, nor now by the Court of Probate, without the consent of the party impugning the custom.

---

* Bracton's definition of a custom is this—"Consuetudo vero quandoque pro lege observatur, in partibus ubi fuerit more utentium approbata, et vicem legis obtinet; longævi enim temporis usus et consuetudinis non est vilis authoritas." (Bracton, fol. ii., ed. Lond. 1569.) This is no inapt definition of a custom observed as if it were law, by those who find it convenient and reasonable; but we can hardly conclude from this passage that this excellent old writer clearly saw that custom could not be law till made so by the sovereign power, or those to whom the sovereign power has delegated parts of its authority.

Such customs of London as do not concern the property of the corporate body itself are proved by a peculiar mode, that of a certificate to the superior courts of law from the lord mayor and aldermen, conveyed by the mouth of their recorder in a solemn ceremonial; without this certificate these courts will not take judicial notice of them.

A particular custom to be valid must have been used "from time whereof the memory of man runneth not to the contrary." This is "prescription," or "title by prescription;" and more accurately describes what is commonly called "time immemorial," which means, says Littleton, "that no living witness hath heard any proof or had any knowledge to the contrary," and as Lord Coke adds, "that there is no proof by record or writing or otherwise to the contrary." It has been doubted whether a prescription (in its proper sense) and a custom can coexist. There is some curious learning on this point collected in the arguments and judgment in Blewitt *v.* Tregoning, 3 Ad. and Ellis. It was held that a custom in a particular market that every pound of butter sold in it should weigh 18 oz. was bad, being directly contrary to a statute of Charles II., which enacted that every pound avoirdupois throughout the kingdom should weigh 16 oz. only. The right to a particular custom must have been continued within time of memory peaceably and without lawful interruption, and will not be lost by mere disuse for ten or twenty years; though in such case to establish it by proof becomes more difficult. But it cannot stand against an express act of parliament to the contrary, for that itself proves a time when the right to such a custom could not exist. It must also be so far reasonable, according to the standard warranted by authority of law that, though no particular origin can now be assigned for it, or though the state of things in which it is known to have arisen has been altered, no good legal reason can be given against its continuance. If it may have had a legal and reasonable origin, it shall be presumed that it actually had it; and its varying from the general law forms no objection, for that is the very essence of a particular custom: but if it be so contrary to any known rule or principle of law, or to the good of the public, or of a multitude of persons, that it cannot be presumed to have had a reasonable commencement in voluntary agreement for some beneficial object, as for securing possessions, promoting trade, or suppressing fraud, it will be void. Thus no length of usage would render good a custom of the secretary of state's office to issue warrants in general terms against the authors, printers, and publishers of a libel, without naming them; that course being contrary to clear and well-settled principles of law, which will not suffer a mere officer to decide on the individuals to be imprisoned. Again, a custom in an inferior court to try causes by six jurors was held bad, as contrary to the common law, though saved in Wales in some instances by a statute of Henry VIII., confirming such custom where it then existed. But long usage and acquiescence in one uniform payment, or in exempting persons particularly situated from contributing to it, are cogent evidence that it is reasonable; for as Lord Mansfield once said, it cannot be presumed that during a long period of years one half the parties were knaves in wrongfully receiving that to which they were not entitled, and the other fools for submitting to an unjust demand. It belongs to the judges of the courts to decide on what is reasonable when brought judicially before them.

Where a custom is harmless in itself, and affords recreation to a number of persons, though to the temporary inconvenience of an individual, it will be upheld and referred to a legal origin. Thus a custom for the inhabitants of a parish to play at cricket, or dance on private property in the parish, was held good, as the lord might have annexed this condition to his original grant of the land. A custom must also be certain as to the description of parties benefited, and compulsory, without its depending on the caprice of any third person whether it can be acted on or not. It must also be consistent; for repugnancy to any other local custom would be plainly contrary to that origin in common consent on which alone it stands; and lastly, it must be strictly pursued, being derogatory of the common law.

Local custom varies from prescription in this: the former is alleged in legal forms as existing not in any person certain, but within a certain named district, without showing any legal cause or consideration for it; whereas prescription must have a presumed legal origin, and is either a personal right, always claimed in the name of a person certain and his ancestors, or those whose estate he has, or by a body politic and their predecessors, or else is in a *que* estate; namely, a right attached to the ownership of a particular estate, and only exercisable by those who are seised of it. All customs of cities, towns, and boroughs, by which persons not freemen were prevented from keeping shops or using trades or handicrafts within them, were abolished by 5 & 6 Will. IV., c. 76, s. 14. [PRESCRIPTION.]

Customs of traders, or seamen, as also of agriculture, mining, &c., will be followed in the construction of contracts, unless they are inconsistent with their express terms, and, subject to that condition, they are admissible even to annex incidents to them as to which they are silent. The "custom of the country" means the custom of all parts of the country to which it can in its nature be applied. Thus a custom that land accruing imperceptibly to the sea-shore belongs to the owners of the shore, applies to all such parts of the realm as adjoin the sea, unless limited in terms to a particular district.

The immemoriality of a particular local custom may be sufficiently proved by living witnesses attesting regular existence for twenty years, unless contradicted by contrary proof. Upon this doctrine will be found to depend a great variety of public as well as private rights to ancient offices, estrays, treasure trove, wreck, nomination of juries, &c.; as well as to tolls of markets, port duties, tithes, ancient rents, &c., and to exemptions from those burdens. The numerical amount of instances in which the privilege claimed can be proved to have existed must be considerable or not, according to the frequency or the rarity with which they may be naturally expected to recur. Thus in a copyhold custom of surrendering in fee so as to bar an entail, a single instance of user, though incapable of making a custom, is evidence sufficient to support it, if not unreasonable in itself.

Reiterated facts of user make a custom of trade; but the mere opinion of merchants is not sufficient for that purpose; nor can any course of action pursued under colour of a custom of merchants alter a general rule of common law when established by judicial decisions.

A long continued usage for exempting particular persons from a local burden, will, if necessary, be supported by presuming that it originated in an act of parliament now lost, though no length of usage will countervail the terms of a statute to the contrary.

CUSTOMS-DUTIES consist for the most part of taxes levied upon goods and produce brought for consumption from foreign countries; such duties are sometimes collected upon exports made to foreign countries, and upon goods and produce passing from one port to another of the same country. Of this nature were the duties on coals, slate, and stone, carried coastwise from one port in the United Kingdom to another, which duties were repealed in 1831. With the exception of a small-rated export duty upon coals, hare-skins, rabbit-skins, and sheep's wool, and an *ad valorem* duty of one-half per cent. on the shipment to foreign countries of some articles of British production, the whole customs-revenue of this kingdom is now derived from duties charged upon the importation for consumption of foreign and colonial merchandise.

The earliest statute passed in this country, whereby the crown was authorised to levy customs-duties, was the 3rd of Edward I. The mode long employed in the collection of these duties was to affix a certain rate or value upon each kind or article of merchandise, and to grant what was called a *subsidy* upon these rates. This subsidy was generally one shilling of duty for every twenty shillings of value assigned in the book of rates. The early Acts granting these duties speak of them as subsidies of tonnage and poundage. The word tonnage was applied to a specific duty charged on the importation of each tun of wine, and the exportation of each tun of beer; and the word poundage was applied to other articles valued as already explained.

The first "book of rates agreed upon by the House of Commons," is believed to be that compiled by a committee in 1642, during the reign of Charles I., and published under the authority of the House by Lawrence Blaiklock. The next book of rates of which we have any record, was also published by order of the House of Commons, in 1660, the year of the restoration of Charles II. In the fifteenth and twenty-second years of the reign of that king, the principle of poundage was altered as respected some articles, and upon those articles specific duties were charged instead, though the system was still followed with regard to the great bulk of articles. But in the reigns of William III. and Anne many additional specific rates were imposed, in place of the valuation for the subsidy. This course of substitution was continued from time to time, and some other innovations were adopted by which the simplicity of the ancient plan was destroyed; so that in a work of authority, published by Mr. Henry Saxby, of the Custom-House, London, in 1757, we find as many as thirty-nine principal branches of customs-duties, with subdivisions applying to different kinds of goods, thereby introducing a degree of complication into the subject which must have caused great embarrassment to traders.

The difficulties here mentioned were increased by the great number of acts of parliament passed from year to year for altering the duties or regulations of this branch of the revenue; and the great bulk and intricacy of the customs-laws had caused such inconvenience, that about the year 1810 the lords of the Treasury employed Mr. Jickling to prepare a digest of those laws. Five years were employed in completing this task, and some idea may be formed of the laborious nature of the work, and of the necessity for its performance, from the fact that the digest forms a large octavo volume of 1375 pages. The work is intituled 'A Digest of the Laws of the Customs, comprising a Summary of the Statutes in force from the earliest period to the 53rd

George III., inclusive.' The effect of the numerous fresh enactments to impair the usefulness of this exposition of the revenue laws was very soon apparent, and in 1823 the late Mr. Deacon Hume, then Comptroller of the Customs in the port of London, was appointed by the Treasury "to undertake the preparation of a general law or set of laws for the consolidation of the Customs of the United Kingdom." In the performance of this duty, Mr. Hume prepared eleven bills, which received the royal assent in July, 1825, and came into operation 1st of January, 1826. These Acts were 6 Geo. IV., caps 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116. The first of these Acts repealed 443 statutes, many of which were obsolete. In 1833, eight of Mr. Hume's Acts were repealed or altered by 3 & 4 Wm. IV., caps. 50, 51, 52, 53, 54, 55, 56, 57. These Acts no doubt effected great improvements in the management of the customs, but cap. 56 enumerated no fewer than 1150 different rates of duty chargeable on imported articles, all other articles paying duty as "unenumerated." In 1840, Mr. Porter, of the Board of Trade, in his evidence before the Parliamentary committee on import duties, showed that out of a total amount of 22,962,610*l.* of customs-duties received in 1839,

	£
17 articles produced 94½ per cent. or . . .	21,700,630
29 articles produced $3\frac{9}{10}$ per cent or . . .	898,661
46 articles produced 98⅖ per cent. or . . .	£22,599,291

In 1842, Sir Robert Peel effected some improvements in this system, which were carried into effect by 5 & 6 Vict. c. 47. This Act reduced the duty on about 750 different articles on which the receipts had amounted to about 270,000*l.* The general principle of the measure was to reduce the duty on raw materials to about 5 per cent., to limit the highest duty on partially manufactured materials to 12 per cent., and on complete manufactures to about 20 per cent. The number of articles in the tariff was now reduced to 813. Foreign horned cattle, sheep, goats, swine, salmon, soles, and other fish, and fresh beef and pork, which had been prohibited formerly, were admitted on paying a duty under the tariff of 1842. In 1844 the duty on foreign wool was abolished. In 1845, Sir Robert Peel effected further improvements in the tariff by abolishing the duty on cotton wool (about 680,000*l.*) and on 430 other articles, on which the duty amounted to 320,000*l.* By this plan expenses of warehousing were saved, and a number of troublesome accounts and impediments to business were got rid of; but for statistical purposes the Customs department retained the power of examining articles which do not pay duty. The paramount object of the tariff reform of 1845 was to encourage the abundance and cheapness of raw materials of manufacture, and the estimated amount of the taxes repealed was 3,614,394*l.*

The following is an abstract from an official 'Expository Statement,' showing the net annual produce of the duties of Customs on all articles imported into the United Kingdom in two years preceding and in two years following the establishment of the new tariff (5 & 6 Vict. c. 47).

Articles producing under the New Tariff.	Old Tariff. £	New Tariff. £
Under £100 . . .	19,037	8,040
£100 to 500 . . .	71,972	34,461
500 to 1000 . . .	69,032	36,258
1000 to 10,000 . . .	570,718	317,492
10,000 to 50,000 . . .	706,991	511,570
50,000 to 100,000 . . .	389,006	395,603
100,000 and upwards . . .	20,810,542	21,417,462
Exempt from duty or prohibited .	196	"
	22,637,494	22,720,886

On 598 articles, the duties on which were altered in 1842, 1843, and 1844, the receipts were 3,851,259*l.* in 1840 and 1841, and 2,478,306*l.* in 1843 and 1844.

On 214 articles, the duties on which were not altered in 1842, 1843, and 1844, the receipts were 18,114,525*l.* in 1840 and 1841, and 19,094,890*l.* in 1843 and 1844.

In 1844 the gross receipt on the following five articles was 15,728,857*l.*:—

Sugar	£4,758,415
Tea	3,884,726
Tobacco	3,093,217
Foreign spirits	2,193,067
Wine	1,799,430

The net amount of duties collected in the United Kingdom on imported articles, after the deduction of drawbacks, repayments, &c. in the last two years of the old tariff and the first two years of the new tariff, was as follows:—

	£		£
1841 . .	23,302,152	On corn, included in preceding column.	568,841
1842 . .	22,356,324		1,363,978
1843 . .	23,450,074		758,295
1844 . .	23,864,494		1,098,383

The following table shows the nature of the tariff previous to the alterations in 1845:—

Articles each producing in 1843–44.	Articles in a raw state for Manufactures.	Articles partially manufactured.	Articles wholly manufactured.	Articles of Food.	Not comprehended under the preceding heads.	Total.
	No.	No.	No.	No.	No.	No.
Under £100	144	54	113	46	91	448
£100 to 500	45	19	31	15	27	137
500 to 1000	16	5	17	6	6	50
1000 to 10,000	28	11	27	28	15	109
10,000 to 50,000	6	5	5	7	2	25
50,000 to 100,000	2	..	..	3	..	5
100,000 and upwards	3	1	1	12	..	17
Exempted from duty or prohibited . .	8	..	2	4	8	22
Total . .	252	95	196	121	149	813

In 1846 the Customs duty on corn was in fact repealed, only a fiscal duty of 1*s.* per quarter being retained. In 1850, (13 & 14 Vict. c. 95) further restrictions were removed; manufactured goods of the Isle of Man and the Channel Islands were admitted free into the United Kingdom; tea and tobacco were allowed to be received by them either from the United Kingdom or elsewhere; and the duty was taken off stringy bark-wood, blue gum-wood, locust-wood, trenails, and some other woods used for ship-building and for shovel-hilts, and also the export duty on coals and culm. The duties on wood received some further alterations in 1852 by the 14 & 15 Vict. c. 62. In 1853, by 16 & 17 Vict. c. 54, the duties on 134 articles, including butter and cheese, were entirely removed, and a reduced tariff imposed on 260 articles, including tea, the estimated amount of the reduction being 1,499,474*l.* In 1856 old metal of any sort, fit only for re-manufacture, was admitted duty free, and in 1857 plums and a few other articles. In 1857 the duty on platina and chloride of lime was repealed, and a few other articles reduced. Notwithstanding these continued reductions, both in the number of articles and the rate of duty imposed, the amount of the customs' duties for the year ending Dec. 31, 1858, was 24,149,215*l.*

The management of the revenue of Customs is committed to a board of nine commissioners, acting as a subordinate department of the Treasury. The commissioners receive a salary of 1200*l.*: the chairman receives 800*l.* in addition, and the deputy-chairman 500*l.*

Nearly one-half of the Customs revenue of the United Kingdom is collected in the port of London, and about one-fifth of the whole in the port of Liverpool. In 1843 the amounts collected at five principal ports was as under:—

London	£11,354,702
Liverpool	4,121,522
Bristol	996,750
Dublin	977,890
Hull	525,418

In 1858 the total amount of the duty was 24,149,215*l.*; to which England contributed 19,619,346*l.*, Scotland 2,264,816*l.*, and Ireland 2,265,053. The chief ports in the United Kingdom stood as follows:

London	£12,332,061
Liverpool	3,622,503
Bristol	1,296,550
Hull	282,387
Newcastle	262,867
Plymouth	228,372
Glasgow	801,895
Greenock	654,694
Leith	479,622
Dublin	1,018,226
Belfast	383,089
Cork	275,724

Those articles of which the importation is prohibited are termed *contraband*, from the Italian *contrabando*, against the proclamation. Since the adoption of the warehousing system in this kingdom, the list of goods the importation of which is prohibited has been made exceedingly short; it comprises at this time (1859) only the following articles:—

Arms, ammunition, and utensils of war, by way of merchandise, except by license from her Majesty for the public stores only.

Books first printed in the United Kingdom, and reprinted in any other country and imported for sale. Notice must be given to the commissioners of Customs by authors or owners that copyright is subsisting.

Clocks or watches, with any mark or stamp representing any legal British assay mark or stamp, or purporting to be of British make, or not having the name and abode of some foreign maker visible on the frame and the face, or not being complete.

Coin, counterfeit, or not of the established standard in weight and fineness.

The list of articles contraband as regards exportation from the United Kingdom is still more limited.

The schedule of prohibitions to importations was formerly much more extensive. Under the Customs Act, 3 & 4 Will. IV. c. 56, cattle, sheep, fresh meat or slightly salted, and fish, were contraband, but under the tariff established by 5 & 6 Vict. c. 47, they have ceased to be so. Tools, utensils, and machinery, for exportation, were also contraband without a license was obtained from the Board of Trade. The Act 6 & 7 Vict c. 84, however, repeals, with some exceptions, the prohibition against machinery.

There are some other prohibitions by which trade in certain articles is restricted; but these refer to the manner in which the trade may be conducted, as the size of the ship, or the package, or the country from or to which the trading may take place, and these being only of the nature of regulations, the articles in question cannot be considered contraband. The list of articles prohibited by many foreign countries is much larger than that enforced in this country; though the system in the case of some of those countries has of late been somewhat relaxed. The tariff of Russia is however still principally filled by designating articles which are contraband.

Another sense in which the term contraband is applied refers to certain branches of trade carried on by neutrals during the continuance of war between other countries. It has always been held under these circumstances, that belligerents have a right to treat as contraband, and to capture and confiscate, all goods which can be considered munitions of war, under which description are comprehended everything that can be made directly and obviously available to a hostile purpose, such as arms, ammunition, and all kinds of naval stores, and all such other articles as are capable of being used with a like purpose, such as horses, and timber for building ships. Under some circumstances, provisions which it is attempted to convey to an enemy's port are contraband, as when a hostile armament is in preparation in that port. These restrictions rest upon principles which are reasonable in themselves, and have been generally recognised by neutrals; others which have at various times been enforced or attempted to be enforced have been contested, but a description of this branch of the subject belongs rather to the matter of International Law, than to a description of contraband trading.

It may be mentioned that all legal disputes respecting the payment of the Customs duties, between the merchant and the crown, are placed for the most part under a summary jurisdiction unknown to the common law, as are most matters of taxation. The popularly constituted tribunal of a jury was early found not to be adapted for the enforcement of laws which, as they interfere with the pocket, must necessarily always be unpopular. The Court of Exchequer, in the last resort, has the control over proceedings for the recovery of this and other branches of the revenue; and in such proceedings the party proceeded against is obliged to prove that he has paid the duties or done the act required, which is contrary to the rule usually observed in the courts.

CUSTOS BRE'VIUM. Officers so called existed until lately in the Courts of Queen's Bench and Common Pleas. They received and had the custody of all the writs returnable in their respective courts, filed warrants of attorney, and various other documents connected with the business of the courts. By the Act 1 Will. IV. c. 58, these offices (of which the duties were performed by deputy) were abolished in both courts, and compensation granted to their possessors. The office in the Court of Queen's Bench was held by Lords Kenyon and Ellenborough jointly, and the compensation granted them was 2089*l.* 17*s.* 4*d.* per annum.

CUSTOS ROTULO'RUM is the chief civil officer of the county, to whose custody are committed the records or rolls of the sessions. He is always a justice of the peace and of the quorum in the county for which he is appointed. The lord-lieutenant has the chief military command of the county, and his office is quite distinct from that of custos rutolorum; but it is the invariable practice to appoint the same person to both offices, in whom is united the highest military and civil authority within the county. By statute 37 Hen. VIII. c. 1, and 1 Will. III. c. 21, he is to be appointed under the sign manual. As he has the custody of the rolls of the sessions, he should attend there in person or by deputy; and this duty is usually performed by the clerk of the peace as his deputy.

CUTLERY. This is a general name for cutting instruments made of steel. Its application, however, is not very definite; for it may or it may not include workmen's tools, and is seldom considered to apply to swords. These last-named implements are, so far as the United Kingdom is concerned, made almost wholly at Birmingham; whereas, table-knives and forks, pen and pocket-knives, razors, lancets, scythes, saws, scissors, snuffers, shears, spades, chisels, awls, plane-irons, &c., are made more largely at Sheffield than in all other parts of the kingdom combined. This is one of those examples of localisation in manufactures, so difficult to trace to its origin.

Table-knives are made of various qualities of metal, from the merest iron up to the finest cast-steel. We will take a medium quality as an example of knife-making. A piece is cut off from a bar sufficient for one knife. The tang, or part which goes into the handle, and the shoulder, between the tang and the blade, are usually made of iron, fashioned by heating, welding, hammering, and swageing. When thus rightly put together, the whole is again heated, and brought into the proper form by further hammering and swageing. The blade is then made red-hot; plunged into cold water to harden; gradually heated again to give the proper temper or elasticity; ground flat and smooth on a large revolving stone; ground sharp at the edge on a smaller stone; and finally polished on a leather-edged wheel faced with a mixture of glue and emery.

Razors are made nearly in the same manner as table-knives, but with more care in the several processes. After the first rough forging, the concavity of the surfaces is produced by hammering the blade on the rounded edge of an anvil. This concavity or hollowing is necessary, to bring the edge to such a degree of thinness as to render keenness attainable; and according as the edge is to be keen or strong, so is this concavity made more or less in degree. The tempering is a much more important process in a razor than in a table-knife, and is dependent on principles which the cutlers themselves do not well understand; the colour of the steel, rather the temperature in degrees of a thermometer, is regarded as the chief test of the heat employed. The grinding and polishing finish the processes.

Table-forks are usually made of commoner steel than knives. A square rod is hammered while in a red hot state, to give roughly the form of the tang and shank; and when again heated, the form is finished by means of a die and swage or stamp. The prongs are fashioned by stamping, by means of a die brought down very heavily upon the steel; the prongs and the middle part of the fork are thus formed, leaving a very thin substance of steel between the prongs, which is afterwards cut out and expelled by means of a fly-press. The forks, thus far made, are heated, then gradually cooled to soften the steel, then filed, then heated again, then suddenly cooled to harden, then ground all over the surface to a smooth and even condition, and finally polished. Of some peculiarities connected with the grinding of forks, we shall speak presently.

Pen- and pocket-knives afford many illustrations of a remarkable diversity of processes in the production of an article which is to be sold at a small price. The blades are made nearly in the same way as those of table-knives; but separate attention is necessary for the bits of steel for the springs, the inner scales of metal which form the framework of the knife, the outer scales of ivory or some other substance which forms the visible handle, and various small pins or rivets. All these fragmentary portions of a knife are put together by a skilled workman; and so numerous are the adjustments, that a common two-bladed knife will pass through his hands seventy or eighty times.

Scissors are made nearly in the same way as knives and razors. Each half is forged, swaged, tempered, ground, and polished separately; but there is a particular series of processes, aided by appropriate tools, for producing the bow or handle. The rivetting, grinding, and polishing, require considerable care.

Grinding.—The work performed by the Sheffield grinders deserves a little separate notice, on account of the peculiar relation which it bears on the one hand to the different kinds of cutlery, and on the other to the health of the workmen. The grinding of table-knives was formerly done upon dry stones, and was considered very injurious to the health of the men. Numerous attempts have been made at various times to remedy the evil, or to lessen its intensity. The most successful plan hitherto devised consists in the employment of a revolving fan, which is connected with a pipe extending from the front of the stone to the exterior of the building; the action of the fan produces a powerful draught in the pipe, which carries off the particles of grit and steel set free during the process of grinding. Were it not for the strength of this current, these particles would be inhaled by the workman, and produce the distressing complaint known as the grinder's asthma. The best preventive of all is to use a wet grindstone; but some kinds of cutlery will not bear this. The better kinds of razors are shaped before they are hardened; and this shaping is effected on a dry stone. The reason for this is, that a stone revolving in water is much softer than when dry; and the action of shaping producing a sort of scraping effect, the wet stone wears away very quickly. As razors, moreover, are shaped on very small stones, there would be considerable loss of time in preparing new ones. The steel also being soft, the operation is more rapidly performed, and no injury is done to the blade by frictional heat. Forks are always ground on dry stones; and hence the most injurious effects are found amongst fork-grinders. During forty years past, the Society of Arts has been endeavouring to introduce some amelioration into the processes of fork-grinding at Sheffield, and needle-grinding at Redditch; but these efforts have not been seconded by the workmen. Mr. Abraham invented a mouth-guard, consisting of a small wooden frame, the upper and lower pieces of which are made curved to fit the lips; in this are fixed two or three layers of crape or muslin—studded with several small magnets to arrest a considerable portion of the deleterious matter before it can reach the crape; to the upper part of the wooden frame is attached a bent wire, to which crape is affixed for protecting the nostrils; and the whole is fastened by two strings passing round the head and tying behind. The fork-grinders refuse to employ this mouth-guard or the revolving fan; they prefer to die of grinder's asthma at thirty or forty years of age. Three causes have been assigned for this recklessness—the troublesome confinement of the mouth-guard; the cost of the ventilating fan; and the fear lest wages should lessen if the grinder's employment became more healthy!

Handles, though not cutlery, form an important branch of Sheffield industry. Indeed not merely one, but many branches; for there are separate workers in ivory, bone, horn, mother of pearl, and other substances, so largely used for handles. Those handles which have a hole for receiving the tang of a knife or fork are known in Sheffield language as *hafts;* while those which consist of two pieces adjusted to their places by rivets, as in the case of clasp-knives, are called *scales*. The various kinds of hafts and scales are made by sawing, planing, filing, piercing, pressing, &c., according to the material employed.

Various other processes connected directly or indirectly with the cutlery trade will be found noticed under FILE; SAW; STEEL.

Certain peculiarities in the Sheffield cutlery operations deserve notice. Two special kinds of buildings in that town are technically known by the short names of *tilts* and *wheels*. A tilt is a building containing all the mechanism necessary for working enormous tilt-hammers. All the steel for the best cutlery is tilted before being used; it is heated to a certain temperature, and then beaten for a considerable time all over its surface, to close up the pores, and render the metal as dense and close as possible. At many of the tilts, or tilt-works, the operations are entirely confined to this tilting or hammering of steel, such tilters working for a large number of cutlers and steel manufacturers. The *wheels* are places in which nothing is done but grinding cutlery and edge-tools upon grindstones or wheels. Formerly these grindstones were worked by water-wheels, turned by some of the rivers which flow through the valleys around Sheffield; and hence the origin of the name wheel, as given to these places; but now large buildings have been constructed, supplied with steam-power; and here the owner either grinds cutlery and edge tools for other persons, or lets out workshops and steam-power to workmen at a definite rental. Such a system could not be profitably conducted, except in a town where the manufacture is carried on very extensively. The fork-grinders, already adverted to as victims of an obstinate adherence to unhealthy processes, form a sort of community by themselves; they work mostly in villages a short distance from Sheffield, rather than in the town itself. The division of labour is remarkable at Sheffield. There is nothing analogous to the factory system of the cotton manufacture; no establishment where a rough piece of iron enters at one door, and comes out finished cutlery at another. A Sheffield manufacturer, generally speaking, has no large manufacturing establishments; he buys his steel of one firm, has it forged by another, ground by another, and finished by another; or he will purchase ready-made goods from manufacturers of less capital; or he will advance money to workmen to purchase material, and agree to give a certain price for the finished articles. It is a mode of conducting business in some degree intermediate between those of the manufacturer and the merchant, as those designations are usually understood. There are a few large firms, however, which have establishments which might be called cutlery factories.

During the last few years, the cutlers of Sheffield have been warmly interested in the question, whether or not the excellence of their manufactures is maintaining its rank, relatively to those of the continent. It is known that the French cutlers were greatly struck by the Sheffield goods displayed at the Great Exhibition of 1851. The quality of the best kinds was better than they could produce. They did not very readily acknowledge the fact at the time; but they determined to profit from the lesson they received, by introducing sundry improvements. When the Paris Exposition was held in 1855, Mr. Moulton, of Sheffield, acted as a member of the jury on that class of exhibited goods which included cutlery. Not as a juror, but in his private capacity, he wrote to Mr. Wilson Overend, chairman of the committee of Sheffield exhibitors, a letter which excited vexation if not surprise among his townsmen, especially when that letter got into the French as well as the English newspapers. He said: "It has been my opinion for some time, that the French were superior to us in point of design for their ornamental work. This I find to be the case in the better kinds of cutlery. In this respect they are superior even to what I expected. And not only so; but the workmanship, or what may be called putting-together, is I consider superior to our best class of manufactured goods. If they are deficient at all, I think it is in their grinding, and I think their table-knives too thick. The Prussians are improving very fast, both in tools and cutlery, and I am informed export to a considerable extent. Many of their goods exhibited were near approaches to Sheffield. I came to the conclusion, then (which is not a new one with me), that Sheffield cutlery, instead of improving as the trade advances in other ways, has been on the decline. While foreigners have been progressing, we have been either stationary or going backwards. There are exceptions of course." The Sheffield cutlers, smarting under this judgment passed by their townsman, met, and passed a formal resolution as a trade-guild, that the opinion of Mr. Moulton was incorrect: in other words, that Sheffield had *not* fallen behind France in the excellence of its cutlery. Some of them insisted that, as their townsman was an edge-tool maker, he ought not to have pronounced authoritatively concerning cutlery, which is a distinct branch of trade. Those who, at that time and afterwards, denied that French cutlery had risen to an equality with English, admitted that there is more grace and delicacy in the handles and the general conformation. Whatever may be the case in reference to high-class goods, it is certain that Sheffield has learned how to produce common goods at wonderfully low prices. This is effected chiefly by substituting casting and cutting-out for forging. In the processes of making the best cutlery, described in the former part of this article, cast-steel is used for the articles which are to bring the highest price. But this does not imply that the articles themselves are cast; the steel is cast into ingots, which are hammered and refined up to a high degree of excellence; and pieces of this steel are cut off, to make the articles of cutlery by forging. The cheap goods, however, are really cast; a mould is made, containing perhaps a dozen or twenty knife, or razor, or scissor patterns; and into this mould molten metal is run. The metal may be entirely iron, or principally iron with a little steel added, and is known in the trade as *run* steel. A little filing, grinding, and polishing, finishes the article, with scarcely any forging. Penknife-blades are often made by stamping a number of small oblong pieces out of a sheet of steel, and forging each separate piece into a blade. A discussion took place at the Society of Arts, on one of the evenings of meeting in 1856, concerning the light in which these goods ought to be regarded. Some of the Sheffield cutlers, then present, regretted that the cheap system had ever come amongst them. It appears that the vine-dressers of France required common and inexpensive scissors for clipping their grapes, seeing that the juice of the fruit attacked the metal, and spoiled good scissors as quickly as bad. Sheffield met the demand, and supplied such scissors at a wonderfully low price. Thereupon, some of the manufacturers determined to make such goods for the general market, to beat out all competitors by the force of cheapness; and then the markets of most countries became stocked with cutlery, which—like the razors celebrated by Goldsmith—were made to sell, not to cut. Mr. Alderman Mechi, accustomed as he is to cutlery of a high class, nevertheless would not admit that the production of cheap goods is industrially a commercial wrong—it becomes a *moral* wrong when such things are sold under false names, appearing to be what they are not. He adduced instances of table-knives and forks sold at 1*s*. 10*d*. per dozen pairs, razors at 1*s*. 6*d*. per dozen, and scissors at 2½*d*. per dozen—all of which would render *a little* service; the manufacturing of such, he contended, was not to be disapproved, unless under one or other of these two circumstances—either that the buyer sold the articles again at a much higher price, by some pretext which would for a time veil the inferiority of their quality; or that the manufacturer recklessly deprived himself of profit, or his workmen of due wages. Sheffield cutlers are, it is admitted, compelled to look sharply after each other, and after their continental rivals. The best firms have trade-marks, each firm stamping a particular mark on all the articles of cutlery made; but there are some dishonest enough to appropriate those marks, and apply them to cutlery which is thereafter sent into the market under false pretences. Some of the Sheffield mark-makers have even allowed themselves to be employed by German houses to imitate the trade-marks of eminent Sheffield cutlers—no-wise in ignorance of the purpose to which the imitative stamps were to be applied.

Of the total amount of the cutlery trade in this country, nothing definite can be stated. In the export trade, cutlery is included with hardware in the Board of Trade returns, which do not afford means for separating the items. In the years 1856–7–8, the quantities and values thus exported averaged about 715,000 cwts. annually, worth 3,813,100*l*.

Our best customer for these products is America.

CUTTING AND STABBING. [MAIM.]

CUTTING, in gardening, is a portion of a plant from which a new individual is propagated when placed in the earth. Everybody knows that a stick of willow stuck into the ground will put forth roots, and become a new plant; such an instance is a rude exemplification of the manner of multiplying plants by cuttings. In the empirical rules to be observed in this operation, the reader had better consult some book on gardening; we shall confine our observations to the theory of the operation.

Every bud which a plant contains is a distinct seat of life, capable, under fitting circumstances, of growing, flowering, fruiting, seeding, independently of all other buds, and able, if separated from the mother plant, to form a new individual. The buds of a vine, and of a potato, are actually so employed under the name of *eyes;* a cutting is merely a small collection of eyes adhering to a mass of woody matter.

A cutting, when prepared for planting, is cut off close to a bud at the bottom, and down to another at the upper end; it is then placed in earth quite up to its topmost bud, the remainder being buried. The object of this is threefold: firstly, to expose only one bud to the stimulus of light, so that when the cutting begins to grow the leaves may not, from their number, require more food than the woody system can supply; secondly, to keep back the other eyes by the pressure of the earth upon them; and thirdly, to expose as great a surface of the cutting as possible to the influence of the moist earth and darkness, by means of which the production of roots will be facilitated.

In delicate operations, where cuttings are difficult to strike, several additional practices are had recourse to. The cuttings are covered with a bell glass, in order to keep the air that surrounds them saturated with moisture, so that when the buds begin to grow they may not exhaust the cutting of its vital fluid by their excessive evaporation. They are shaded with the same object in view; sun-light increases evaporation, and stimulates a growing part into action: the desire of the gardener is to guard against this till his cuttings have formed abundant roots to feed by. When cuttings are very difficult to strike, their lower end is often made to rest upon the bottom of the garden-pot in which they are to grow; this removes their wounded end from too much moisture, and prevents their being gorged with crude sap before they are able to digest it, an evil quite as great as that of being exhausted by too rapid evaporation. The same or a similar purpose is answered by putting the cuttings in the first instance into pure silex (silver sand), from which they are removed as soon as roots are emitted; such sand permits only a slow transmission of water through it, and is in fact incapable of supersaturation if proper means are taken to drain it; and hence it renders it impossible that water should be conveyed too quickly into the open vessels of the cutting.

In many cases a single leaf, or a portion of one, is left attached to the upper eye of the cutting; this is for the sake of keeping up a slow circulation in the system, and of drawing into the vessels of the wood a gentle current of moisture, so that the cutting may never be too much exhausted.

When cuttings will not strike because they are too young, the cause is to be sought in the young tissue being too absorbent, and taking up moisture faster than it can digest it, the result of which is a repletion of the vessels, disease, and death. On the other hand, cuttings the wood of which is too old will not strike from an opposite cause; their vessels are so clogged and rigid, that when the young leaves are ready to expand, and the new roots to develop, the supply of food moves too sluggishly through the cutting from point to point, and hence the new parts wither if formed, or will not form at all. The exact age at which a cutting roots most readily is a matter of experiment, and not capable of being reduced to any theoretical rule.

It is highly probable that if these points are well considered, all plants, of whatever nature, provided they have well-formed buds, are capable of striking from cuttings; and it is notorious, that while some gardeners can only succeed with the commonest things, others, by the success that attends their operations, possess what would seem a magical power over plants, if we did not know that natural magic consists in nothing more than the right application of right knowledge at the right time.

CYAMELIDE (C_2HNO_2). A white solid substance isomeric with hydrated cyanic acid. [CYANIC ACID.] It is non-crystalline, inodorous, and insoluble in water, alcohol, ether, or dilute acids. It has no acid properties. By heat it is volatilised and reconverted into hydrated cyanic acid. Hot concentrated sulphuric acid decomposes it, sulphate of ammonia is formed and carbonic acid evolved. It is not acted upon when boiled with hydrocloric or nitric acids. Heated with caustic potash, ammonia is disengaged and cyanate and cyanurate of the base formed.

CYAMELURIC ACID ($3HO, C_{12}N_7O_3$) is obtained in combination with potash on heating mellonide of potassium [MELLON] with excess of caustic potash; the salt crystallises from an aqueous solution in needles. The other *cyamelurates* are obtained by double decomposition; some of them are crystalline. Cyameluric acid may be isolated from a solution of a cyamelurate by the addition of nitric or hydrochloric acids; it then falls as a white semicrystalline precipitate. Boiled with nitric acid it gives cyanuric acid.

CYAN—CYANO, prefixes used in forming the names of certain chemical substances into the composition of which cyanogen enters. [CHLOR—CHLORO.]

CYANAMIDE $\left(NCyH_2 = N\begin{cases}Cy\\H\\H\end{cases}\right)$ is best prepared by passing gaseous chloride of cyanogen into a saturated ethereal solution of ammonia (NH_3). Chloride of ammonium deposits, and the ethereal solution yields on evaporation white crystals of pure cyanamide.

Cyanamide is soluble without alteration in alcohol, and also in water, but on evaporating the aqueous solution melamine results, a compound containing three molecules of cyanamide. [MELAMINE.] Cyanamide fuses at 104°, and recrystallises unchanged on cooling, but if the temperature is raised to 300° it suddenly solidifies, evolves heat, and is converted into melamine. The addition of nitric acid to an ethereal solution of cyanamide causes the assimilation of two equivalents of water and formation of nitrate of urea.

If, in the above process for the preparation of cyanamide, ammonia be substituted by methylamine, ethylamine, amylamine, diethylamine, methylethylamine, &c., corresponding cyanamides are obtained, in which one or both of the equivalents of hydrogen are replaced by methyl, &c., forming monomethylcyanamide, monoethylcyanamide, diamylcyanamide, &c.; or one equivalent of hydrogen may be replaced by one radical and the other equivalent of hydrogen by another radical forming a compound cyanamide, thus methylethylcyanamide.

Cyananilide, $N\begin{cases}C_{12}H_5\\Cy\\H\end{cases}$, is a compound similar to those just described: it is, in *fact*, phenylcyanamide or cyanamide in which one of the two equivalents of hydrogen is replaced by phenyl ($C_{12}H_5$). It is formed, as above indicated, by replacing the ammonia, $N\begin{cases}H\\H\\H\end{cases}$ in the preparation of cyanamide by phenylamine (aniline) $N\begin{cases}C_{12}H_5\\H\\H\end{cases}$. Cyananilide has not been obtained in crystals; it resembles in appearance common resin.

Two molecules of cyanamide and one of cyanic acid form ammeline [AMMELINE]. One of cyanamide and two of cyanic acid form ammelide. [AMMELIDE].

Chlorocyanamide ($2NCyH_2, CyCl$), formed on adding solid chloride of cyanogen to solution of ammonia, contains two molecules of cyanamide and one of chloride of cyanogen.

CYANANILIDE. [CYANAMIDE.]

CYANATES. [CYANIC ACID.]

CYANETHINE ($C_{18}H_{15}N_3$), is an organic base, polymeric with cyanide of ethyl, and containing three molecules of that body.

$$\underbrace{C_{18}H_{15}N}_{\text{Cyanethine.}} = \underbrace{3(C_4H_5, NC_2)}_{\text{Cyanide of ethyl.}}$$

Cyanethine is produced by the action of potassium on cyanide of ethyl imperfectly dried; hydride of ethyl is evolved and the residue contains cyanide of potassium and cyanethine. It crystallises from boiling water in pearly plates. Cyanethine forms salts with acids; the *nitrate* ($C_{18}H_{15}N_3, HO, NO_4$), crystallises in large colourless prisms.

CYANIC ACID ($C_2HNO_2 = CyO, HO$), is best prepared by distilling dried cyanuric acid [CYANURIC ACID], the receiver being kept cool by a freezing mixture. It is a limpid colourless liquid of an exceedingly penetrating odour, resembling very strong acetic acid. It acts upon the skin as powerfully as red-hot iron, occasioning much pain. Cyanic acid is very unstable, spontaneously changing in a few hours to an opaque solid resembling porcelain. [CYAMELIDE.] During this change no decomposition takes place, but the molecules probably undergo rearrangement. Water converts cyanic acid into bicarbonate of ammonia.

A combination of cyanic and hydrochloric acids has been obtained by M. Wöhler. It fumes strongly in the air, and has an odour resembling a mixture of the two acids.

Cyanates are nearly all formed by double decomposition with the potash salt. *Cyanate of potash* (KO, CyO) is readily produced on adding finely powdered oxide of lead to fused cyanide of potassium:—

$$\underbrace{KCy}_{\substack{\text{Cyanide of}\\\text{potassium.}}} + \underbrace{2PbO}_{\substack{\text{Oxide of}\\\text{lead.}}} = \underbrace{KO,CyO}_{\substack{\text{Cyanate of}\\\text{potash.}}} + \underbrace{Pb_2}_{\substack{\text{Metallic}\\\text{lead.}}}$$

The metallic lead and excess of oxide sink to the bottom of the crucible and the melted mass may be poured out upon a plate. It can be purified by solution in alcohol, and obtained in crystals by evaporation. The *lead salt* (PbO, CyO) and the *silver salt* (AgO, CyO) fall as white precipitates on mixing solution of cyanate of potash with solutions of nitrate of lead or nitrate of silver.

Cyanate of ammonia (NH_4O, CyO), in solution, is after a time entirely changed into urea. [UREA.] The same transformation occurs immediately on boiling the solution. No decomposition occurs in either case. [CYANOGEN.]

CYANIC AMIDE. [CYANAMIDE.]

CYANIC ETHER. [ETHERS.]

CYANIDES. [CYANOGEN.]

CYANILIC ACID ($3(HO, CyO)$, is metameric with cyanuric acid. The two acids resemble each other very closely, but the former is much more soluble than the latter. Cyanilic acid is formed on boiling hydromellon [MELLON] with nitric acid. It crystallises in efflorescent, oblique, rhomboidal prisms. Strong sulphuric acid converts it into cyanuric acid.

CYANILINE ($C_{12}H_7N, Cy$). Aniline absorbs cyanogen, and after a time deposits crystals of a basic substance capable of combining with acids like aniline itself. It is formed by the direct union of the cyanogen and aniline, and is called cyaniline. It is very slightly soluble in cold alcohol, and but little more so in boiling alcohol. It fuses at about 420° Fahr., and at a higher temperature is decomposed. Both cyaniline and its salts are very unstable.

CYANIN. MM. Fremy and Cloëz have given this name to the colouring matter that produces the red and blue tints of various flowers, the red becoming blue in the presence of an alkali, or, if the latter is in excess, assuming more or less of a green tint: in the same way an acid causes blue cyanin to assume a rose colour.

Cyanin may be obtained from the petals of the violet or iris by digestion in boiling alcohol. It has never been obtained sufficiently pure for analysis. Deoxidising agents decolorise it, and it again becomes coloured under the influence of oxygen. It is uncrystallisable. [COLOURING MATTERS.]

CYANOGEN ($NC_2 = Cy$). A gaseous compound of the elements nitrogen and carbon, in the proportions of one equivalent of the former and two of the latter, or fourteen parts by weight of nitrogen, and twelve of carbon. It was discovered in the year 1815 by Gay Lussac, though some of its compounds were known long before that date.

Thus a beautiful blue pigment, now known to be a compound of cyanogen and iron, was accidentally discovered in Prussia, at the commencement of the 18th century, by Diesbach, and called by him *Prussian blue*. From this compound Scheele, in 1782, obtained a substance that on account of its source and properties he called *Prussic acid* (hydride of cyanogen, or hydrocyanic acid). Prussic acid was ascertained to be composed of carbon, nitrogen, and hydrogen, by Berthollet in 1787; and Gay Lussac finally determined its true constitution, and isolated cyanogen itself in 1815.

Cyanogen derives its name from two Greek words, *κύανος, blue*, and *γεννάω, to produce*, because it was first discovered in, and is an essential ingredient of, Prussian blue.

Cyanogen is exclusively a product of the animal and vegetable kingdoms. It nowhere exists free in nature. Combined with hydrogen, it occurs to a considerable extent in the juice of the bitter cassava. [CASSAVA, NAT. HIST. DIV.] The same compound of cyanogen is also produced by the decomposition of certain nitrogenised principles in fruits, when the latter are distilled with water. [AMYGDALIN.] Refuse animal matter, such as the parings of hoofs, hides, horns, &c., is the ultimate source of the many cyanogen compounds used at the present day in the arts and manufactures. These animal matters all contain nitrogen and carbon, and at a high temperature furnish cyanogen. [POTASSIUM, FERROCYANIDE OF.]

A point of considerable interest connected with cyanogen, is that it was the first discovered of those compound bodies that in their combinations and general properties so much resemble elements. Its discovery gave to organic chemistry an impetus such as it had never before received, and to which it owes no small share of its present position.

Cyanogen cannot be formed by the direct union of its elements, but is easily prepared by heating bicyanide of mercury ($HgCy_2$) [MERCURY, *Bicyanide of*] in a retort, or any other vessel from which gas may be conveniently collected.

Cyanogen is a transparent, invisible gas of a peculiar penetrating odour. It is excessively poisonous. Its specific gravity is 1·8064. It is tolerably soluble in water, much more so in alcohol, and must therefore be collected by displacement, or better over mercury. [GASES, COLLECTION OF.] It burns with a very beautiful peach-blossom coloured flame. By a pressure of several atmospheres it is condensed into a colourless liquid; and at a temperature of 30° Fahr., solidifies into a crystalline mass. It supports a very high temperature without alteration, unless iron be present, when at a full red heat it is decomposed into nitrogen gas and carbon.

Metallic cyanides, formed by the union of cyanogen with metals, may be easily prepared by indirect methods. See the various metals.

Cyanogen and *hydrogen* form only one compound.

Hydrocyanic acid (CyH); *prussic acid*. The constituents of this acid cannot be made to unite directly, but the compound is readily formed on adding a strong acid to a metallic cyanide, cyanide of potassium for example, and may be rendered anhydrous by passing the vapour over fragments of chloride of calcium. The reaction that takes place is a simple one :—

$$\underbrace{KCy}_{\substack{\text{Cyanide of}\\\text{potassium.}}} + \underbrace{HO, SO_3}_{\substack{\text{Sulphuric}\\\text{acid.}}} \quad \underbrace{KO, SO_3}_{\substack{\text{Sulphate}\\\text{of potash.}}} + \underbrace{HCy}_{\substack{\text{Hydrocyanic}\\\text{acid.}}}$$

By cooling the receiver into which the vapour is conducted, the pure acid is obtained as a colourless transparent liquid.

Anhydrous hydrocyanic acid is very volatile, boiling at 79·7°. For this reason great care is requisite in the preparation and manipulation of it, as the inhalation of an exceedingly small quantity of the vapour rapidly destroys life. So quickly does it evaporate at common temperatures, that a drop exposed on a glass plate soon solidifies to a mass of silky fibres on account of the cold produced by volatilisation. The same effect occurs in a closed tube, on reducing its temperature by means of a freezing mixture to 5° Fahr. The vapour of this acid burns with a white flame.

Diluted hydrocyanic acid, containing two parts of the anhydrous acid to ninety-eight parts of water, is a preparation much used in medicine. Directions for preparing it of this strength are given in the 'London Pharmacopœia,' but manufacturers, to save time and expense, prepare it in a tolerably concentrated state, determine its strength by means of nitrate of silver, and then so dilute it with water that one hundred grains of the liquid shall precipitate the whole of the silver contained in a solution of 12·59 grains of pure nitrate of silver; it then constitutes the officinal preparation. The manufacture of the acid is conducted in stoneware stills or large retorts. Ferrocyanide of potassium [POTASSIUM, *Ferrocyanide of*], dissolved in water, and sulphuric acid are introduced into the still and heat applied; a strong solution of the acid distils over and is condensed in a well cooled refrigerating apparatus; the end of the stoneware worm, or condensing tube, should dip just below the surface of a little water contained in a vessel surrounded with ice. The decomposition that takes place is thus expressed :—

$$\underbrace{2(FeCy, 2KCy)}_{\substack{\text{Ferrocyanide}\\\text{of potassium.}}} + \underbrace{6(HO, SO_3)}_{\text{Sulphuric acid.}} = \underbrace{(KCy, 2FeCy)}_{\text{Everitt's salt.}} + \underbrace{3(KO, HO, 2SO_3)}_{\substack{\text{Bisulphate of}\\\text{potash.}}} + \underbrace{3HCy}_{\substack{\text{Hydro-}\\\text{cyanic}\\\text{acid.}}}$$

The hydrocyanic acid prepared by this process nearly always contains a trace of sulphuric acid, but this is rather advantageous than otherwise, for when quite pure the aqueous solution of the acid is very liable to decompose, but does not do so when the smallest possible quantity of sulphuric or hydrochloric acid is present.

Tests for cyanogen.—In all simple combinations as, for example, in solution of hydrocyanic acid, the cyanogen may be detected by the following methods. Solution of nitrate of silver produces a white curdy precipitate soluble in boiling nitric acid, and decomposed when heated in the dry state with separation of metallic silver. The addition of small quantities of solutions of caustic potash or soda, protosalt of iron, and persalt of iron, causes a precipitate of oxides of iron; by the addition of hydrochloric acid the oxides of iron in excess are dissolved, whilst prussian blue of characteristic colour remains suspended in the liquid. Another very delicate test consists in adding a few drops of strong sulphuric acid to a small portion of the suspected substance contained in a watch-glass, over which is inverted another watch-glass moistened with yellow sulphide of ammonium. If cyanogen is present the sulphuric acid is set free under the form of hydrocyanic acid, and this with the sulphide of ammonium forms sulphocyanide of ammonium (NH_4, CyS_2). Excess of sulphide of ammonium must now be got rid of by heating the upper watch-glass till quite dry, at a temperature not exceeding that of boiling water. The addition to it when cold of a drop of a dilute solution of sesquichloride of iron causes the production of an intense red colour (sulphocyanide of iron). This mode of detecting cyanogen may be adapted to the two preceding tests, the upper watchglass being of course in the one case moistened with solution of nitrate of silver, and in the other with the mixed solutions of the salts of iron. In endeavouring to detect the presence of hydrocyanic acid, the peculiar odour of the faintest trace of that substance should ever be remembered as a valuable aid.

Cyanogen and *oxygen* form no les than six compounds, all having the same per-centage composition but differing markedly, and some considerably, from each other. It will be convenient to describe them in separate articles. [CYAMELIDE; CYANIC ACID; CYANILIC ACID; CYANURIC ACID; FULMINIC ACID; FULMINURIC ACID.] Their relation to each other may be thus expressed :—

Cyanuric acid . . .	$C_6H_3N_3O_6$	$= 3HO, C_6N_3O_3$	$= 3(HO, CyO)$
Cyanilic acid . .	$C_6H_3N_3O_6$	$= 3HO, C_6N_3O_3$	$= 3(HO, CyO)$
Fulminuric acid . .	$C_6H_3N_3O_6$	$= HO, C_6H_2N_3O_5$	$= 3(HO, CyO)$
Fulminic acid . .	$C_4H_2N_2O_4$	$= 2HO, C_4N_2O_2$	$= 2(HO, CyO)$
Cyanic acid . . .	$C_2H\ N\ O_2$	$= HO, C_2N\ O$	$= (HO, CyO)$
Cyamelide . . .	$C_2H\ N\ O_2$	$= HN, C_2O_2$	$= (HO, CyO)$

Cyanogen and *nitrogen*. [CYANAMIDE.]

Cyanogen and *chlorine* form three isomeric compounds, the first gaseous, the second liquid, and the third solid.

Gaseous chloride of cyanogen ($CyCl$) is obtained by passing chlorine gas into strong hydrocyanic acid, or by conveying chlorine over moist cyanide of mercury excluded from the light. It may be collected over mercury.

This compound is a colourless gaseous body, extremely pungent, and soluble in water, alcohol, and ether. At zero it forms a colourless crystalline mass, and this at 5° melts into a liquid which boils at 11°. When subjected to pressure of four atmospheres it assumes a liquid form; and if long kept it is converted into the solid chloride. It is composed of 1 equivalent of chlorine 35·5 + 1 equivalent of cyanogen 26 = 61·5. Spec. grav., 2·124.

Liquid chloride of cyanogen (Cy_2Cl_2) is produced when cyanide of mercury is exposed to the action of chlorine in direct sunlight. It is a liquid, boiling at 61° Fahr., and solidifying to a mass of crystals at 19°. Equivalent, 123.

Solid chloride of cyanogen, chlorocyanic acid (Cy_3Cl_3). This compound is obtained when anhydrous hydrocyanic acid is exposed to chlorine gas acted upon by the sun's rays; hydrochloric acid being also formed. It has the form of long colourless needles, which have a powerful and disagreeable odour. The crystals fuse at 284°, and sublime unaltered at a higher temperature. It dissolves in alcohol and ether without decomposing; but when heated with water it is decomposed into cyanuric and hydrochloric acids. It was probably owing to the formation of these acids that chloride of cyanogen was originally supposed to possess acid properties; and hence the name of chlorocyanic acid. It may be considered as composed of 3 equivalents of chlorine 106·71 + 78 = 184·71. Vapour density, 6·39.

Cyanogen and *bromine*, and

Cyanogen and *iodine*, form solid combinations. They are obtained on distilling cyanide of mercury with bromine or iodine.

Cyanogen and *sulphur* form a *bisulphide* (CyS_2). This substance cannot be obtained in the free state. In its combinations it partakes of the nature of cyanogen itself, forming compounds in the same manner as an elementary body. For this reason it is usually considered to be a compound radical, and is called *sulphocyanogen*; its symbol as such is (Scy). The salts that it forms with the metals very much resemble in constitution the corresponding compounds with cyanic acid, the oxygen in the latter being replaced by sulphur.

Hydrosulphocyanic acid ($HCyS_2$), or *sulphocyanide of hydrogen* (H, Scy), may be regarded as hydrated cyanic acid (HO, CyO), in which the oxygen is substituted by sulphur, and may be written thus,—

(HS, CyS). It is usually however expressed by the formula (H, Scy), and the other sulphocyanides by the general formula (M, Scy). This acid may be isolated by exposing subsulphocyanide of mercury to a current of sulphuretted hydrogen. It is a colourless liquid. By exposure to a low temperature it solidifies to a mass of crystals. It is unstable, soon decomposing into hydrocyanic acid and *hydropersulphocyanic acid* ($H_2Cy_2S_6$).

Sulphocyanide of potassium (K, Scy) is formed by fusing together sulphur and cyanide of potassium, or by heating in a covered crucible at a dull red heat a mixture of 46 parts of dried ferrocyanide of potassium, 32 of sulphur, and 17 of pure carbonate of potash. The cooled mass is digested in water, filtered, the filtrate evaporated to dryness, and the residue digested in hot alcohol. On cooling, the liquid deposits the salt in beautiful crystals.

Other sulphocyanides are obtained by double decomposition with the potassium salt. The sulphocyanides of barium, calcium, and iron are soluble; those of mercury, lead, and silver are white insoluble precipitates. Soluble sulphocyanides give, with ferric salts, an intense red solution, owing to the formation of persulphocyanide of iron. This reaction is characteristic.

Chlorine and nitric acid act upon sulphocyanic solutions, producing a yellow precipitate, the composition of which has not been satisfactorily determined. By heat this precipitate is altered into a substance called by Liebig *crude mellon*. [MELLON]. *Melam* is the name given by Liebig to the residue of the destructive distillation of sulphocyanide of ammonium. [MELAM.]

Cyanogen and *selenium* form combinations corresponding in composition and properties to the sulphocyanic compounds.

Metallic Derivations of Cyanogen.—Cyanide of potassium forms double salts with the cyanides of cobalt, copper, iron, chromium, platinum, and iridium. It is usually assumed that in these salts the potassium is combined with electro-negative compound salt-radicals, to which have been given the names *cobalticyanogen*, *cuprocyanogen*, *ferrocyanogen*, *chromicyanogen*, *platinocyanogen*, *platinidcyanogen*, and *iridiocyanogen*. Some of these are monobasic, some dibasic, and others tribasic. They form, with hydrogen, a well-marked series of acids. The following list of these acids, with their formulæ, will at once indicate their constitution:—

Hydroplatinocyanic acid	$H, Pt Cy_2$
Hydroiridiocyanic acid	$H, IrCy_2$
Hydroplatinidcyanic acid	H_2, Pt_2Cy_5
Hydroferrocyanic acid	H_2, Fe_2Cy_3
Hydroferridcyanic acid	H_3, Fe_2Cy_6
Hydrocobalticyanic acid	H_3, Co_2Cy_6
Hydrochromicyanic acid	H_3, Cr_2Cy_6
Hydrocuprocyanic acid	?

The methods of preparing the most important of the above acids will be found described in the articles on the different metals that enter into their composition.

By the replacement of the hydrogen in these acids by an equal number of equivalents of a metal, a numerous class of salts is formed, some members of which are largely used in the arts. Thus, by substituting the two equivalents of hydrogen in hydroferrocyanic acid by two of potassium, we obtain ferrocyanide of potassium (K_2, $FeCy_3$, or K_2Fcy), the common yellow prussiate of potash. From hydroferridcyanic acid (H_3, Fe_2Cy_6, or H_3, Fdcy) we derive ferridcyanide of potassium (K_3, Fe_2Cy_6, or K_3Fdcy), ordinary red prussiate of potash. For details of the preparation of the principal of these salts, see the various metals.

Hydronitroferrocyanic acid, or *hydronitroprussic acid* ($H_2, Fe_2Cy_5NO_2$), is produced when binoxide of nitrogen (NO_2) is passed through a solution of hydroferridcyanic acid. The decomposition that takes place is thus expressed:—

$$\underbrace{H_3Fe_2Cy_6}_{\text{Hydroferridcyanic acid.}} + \underbrace{NO_2}_{\text{Binoxide of nitrogen.}} = \underbrace{H_2, Fe_2Cy_5NO_2}_{\text{Hydronitroprussic acid.}} + \underbrace{HCy}_{\text{Hydrocyanic acid.}}$$

Hydronitroprussic acid may be obtained in prismatic crystals of a deep red colour, containing two equivalents of water. *Nitroprussides*, containing two equivalents of a metal in the place of the hydrogen in the acid, are readily formed. The sodium salt crystallises in fine ruby-red prisms; the barium salt in beautiful octohedra. For details of the preparation of these salts, see papers by Playfair in the 'Philosophical Transactions,' 1849 and 1850.

The characteristic test for nitroprussides is the production of a beautiful purple colour on the addition of an alkaline sulphide. Traces of sulphur on the one hand, or of a nitroprusside on the other, may thus be detected with certainty; the colour is however very fugitive.

CYANOMETER, from the Greek words *κυανός* (blue) and *μέτρον* (a measure), is an instrument which was invented by M. de Saussure for the purpose of enabling an observer to *measure* the intensity of *blue* colour in the sky.

It is well known that the visible heavens, when free from clouds, appear to have a blue tint which gradually increases in intensity from the horizon towards the zenith, that the blueness is more intense by night than by day, and that on the tops of mountains the colour is sometimes so deep as to be almost black. These appearances depend partly on the different extents of atmosphere which the rays of light have to pass through, and partly on the quantity of water which the air holds in solution. It has been supposed that the gaseous fluid, air, is of a *blue* colour; the colour being so slight as to be seen only when we look through large masses of air; and that it is to this cause that distant mountains owe their peculiar bluish tint. When, as towards the zenith, the atmospheric space traversed by the light is comparatively small, the violet and blue rays are transmitted to the earth in abundance; while, towards the horizon, the spaces passed through being greater and being charged with vapours, the violet, the blue, and even the green rays are intercepted, the remaining colours only of the spectrum being transmitted: it must, however, be added that the colour of the sky is affected by the terrestrial particles which are occasionally raised in the atmosphere; and also by the reflections of light from terrestrial objects, particularly from naked rocks and from masses of snow or ice. The colour of the sky being thus, in some measure, an indication of the state of the atmosphere with respect to exhalations and the reflections of light from the earth's surface, it is of importance to ascertain with some precision the intensity of that colour.

The cyanometer, as formed by the inventor, consists of a circular plate or ring, of metal or pasteboard, on the surface of which, about the circumference, is a band divided by radii into fifty-three equal compartments. One of these is white, and those which follow in succession are coloured with blue of different degrees of intensity, from the most faint to the deepest which can be produced; the rest of the compartments are coloured with mixtures of Prussian blue and ivory black, and gradually increase in darkness to the last division, which is quite black.

In using the instrument, the observer, who should be in the open air, holds it up between himself and that part of the sky of which he intends to ascertain the colour; and this part should be such that, while the face of the instrument is strongly enlightened, the direct rays of the sun may not fall upon it: on turning the plate or ring in its own plane, till there is brought directly before the observed part of the sky that compartment which, to the eye, appears to be exactly equal to it in intensity of tint, the number of the compartment will express the required intensity of the blue colour in that part of the sky.

In order to form a scale of numbers for the tints, M. de Saussure placed against a wall a piece of white paper, on which was a circular black spot, about one-seventh of an inch in diameter, and receded from it till the spot ceased to be visible; he then laid on paper a tint produced by Prussian blue, so diluted that, at a distance from it equal to that at which the black spot became invisible, the tint could not be distinguished from a perfect white. This tint was marked No. 1. The next deeper colour was produced by diluting the Prussian blue till, at an equal distance, the tint ceased to be distinguished from that of No. 1, the latter being near the eye: this was marked No. 2; and each of the succeeding numbers up to No. 53 was determined in like manner by a comparison of the corresponding tint with that which preceded it on the plate.

Arago invented a cyanometer, which acts on the same principle as his photometer. The *latter* instrument is thus formed: Two lenses are placed, one on the other, so as to form coloured rings about the point of contact, which, as is well known, are seen as well by transmitted as by reflected light, the one set being complementary to the other. These two series of rings neutralise one another mutually when the two lights which form them, and which fall simultaneously on the lenses, are of equal intensity. His cyanometer is an extension of this principle. It is formed of a tube closed at one end by a plate of rock-crystal cut perpendicularly to its axis, and, at the end nearest the eye, by a doubly refracting prism. Among the colours which this apparatus gives, when polarised light traverses it, and the prism is turned on its axis, is the peculiar blue colour of the sky, which varies in intensity according to the proportion of polarised light admitted by turning the prism.

Suppose now that this polariscope be directed upon a piece of white paper, and that between the paper and the plate of rock-crystal there is placed a pile of plates of glass, which can be moved in an angle, so as to vary their inclination, and make the bright light from the paper more or less polarised. The blue colour seen in the instrument goes on increasing in intensity with the inclination of the pile, until it appears the same as that of the region of the sky which we are observing. The measure of this cyanometric tint is then given by the inclination of the pile, and if the pile be composed of the same number of plates, and the same kind of glass, the observations made with this instrument will be of course comparable.

CYANOSIS, or **BLUE DISEASE**, is a condition of the system which comes on as the result of a malformation of the heart, which allows the venous and arterial blood to mingle in the system. In the fœtus the circulation is of such a kind as to prevent the blood flowing from the placenta passing through the lungs, and this is done by a communication between the pulmonary artery and the aorta—the *ductus arteriosus*; and an opening between the right and left ventricle—the *foramen ovale*. After birth these two communications between the right and left side of the heart are normally closed, but it occasionally happens that one, or both, passages do not close at birth or that they open again in after life. The consequence of this malformation is that the venous blood passes to the left side of the heart without undergoing its proper amount of oxygenation in the lungs. The effect of this abnormal mixture of the two bloods is not to destroy life immediately, but to produce a series of symptoms, the most prominent of which is a blueness of the skin, constituting the disease called cyanosis. This is not an unfrequent occurrence, and according to the extent of the communication between the two sides of the heart will be the intensity of the disease. Sometimes the feebleness and derangement of the system causes death within a few hours after birth; in other cases persons have been known to attain mature age labouring under this affection.

The effect of this malformation, according to its degree, is to diminish the nutrition of the body, and to produce general weakness and exhaustion. The functions of the heart and lungs are interfered with, and there is frequently a rapid intermitting pulse, with attacks of difficulty of breathing. The blueness of the skin is increased during these attacks. There is generally coldness of the skin from the imperfect nature of the respiratory changes which go on in the body. There is also a tendency to dropsical effusion in various parts of the body.

In this disease little can be done to effect a cure. The great object is to alleviate any distressing symptoms which may arise.

CYANOXALIC ACID. [Uric Acid.]

CYANURENIC ACID, an acid found in the urine of the dog. It much resembles uric acid, but differs in being soluble in hydrochloric acid. It is obtained from the tenacious deposit that forms when the urine of the dog is set aside for some time. That substance is dissolved in lime-water, and sufficient hydrochloric acid added to neutralise the lime; cyanurenic acid then separates in the form of small colourless needles. It is insoluble in alcohol, is sublimed by heat, and is then soluble in alcohol. It forms salts with bases, some of which are crystalline.

CYANURIC ACID ($3(HO, CyO) + 4Aq.$, or $3HO, C_6N_3O_3 + 4Aq.$). This acid was discovered by Scheele in the distillation of uric acid; more lately Serullus obtained it by another process, and described it under the name of cyanic acid; and lastly, Wöhler and Liebig examined its constitution and properties.

This acid is formed under various circumstances, as by the decomposition of solid chloride of cyanogen by water, the decomposition of soluble cyanates by dilute acid, and the distillation of uric acid, &c.

In order to prepare it, the best process seems to be to dissolve dry melam [Melam] with a gentle heat in concentrated sulphuric acid; the solution is to be poured into 20 or 30 parts of water, and the mixture is to be kept for several days, at a temperature near ebullition, or until small portions yield no white precipitate with ammonia. The solution is then to be evaporated to its crystallising point, and the crystals obtained are to be purified by recrystallisation.

Cyanuric acid forms rather small colourless prismatic crystals, which are efflorescent, losing at ordinary temperatures the whole of their water of crystallisation. It is very slightly soluble in cold water, and requires 24 parts of boiling water to dissolve it; it is inodorous, has but little taste, and reddens litmus but feebly. It is a remarkably permanent substance, being soluble without decomposition in concentrated sulphuric or nitric acid, though when heated in them it is eventually decomposed.

According to Liebig, the crystallised acid consists of 3 equivalents of cyanogen 78, 3 equivalents of oxygen 24, 7 equivalents of water 63, equivalent = 165: 3 equivalents of the water constitute the acid a hydrate, and 4 equivalents are water of crystallisation. It combines with 3 equivalents of base to form cyanurates, and is therefore what is termed a tribasic acid. By exposure to a very high temperature 1 equivalent of hydrated cyanuric acid is decomposed into 3 equivalents of hydrated cyanic acid. Urea is by heat converted into cyanuric acid and ammonia.

CYBELE. [Rhea.]

CYCLAMIN. [Arthanitin.]

CYCLE, which means nothing but circle (κύκλος), has an arbitrary use in chronology. Certain of the cycles, or recurring methods of denoting time, which are in common use, are called cycles, to the exclusion of the rest. The principal of these, if not the only ones, are the Metonic cycle [Meton, Biog. Div.; Calippus, Biog. Div.], the solar cycle, and the cycle of Indiction. But the natural cycles, such as the revolutions of the sun and moon, are not called cycles; nor even some of the artificial ones, such as the Julian *period*. It would be useless to retain this artificial and confused distinction. Under the distinctive words Meton, Biog. Div., Indiction, &c., the reader will find the origin of each method of reckoning; while in the article Period of Revolution, he will see a table of the lengths and commencements of all the cycles, natural and artificial, whether called cycle, period, year, day, or month.

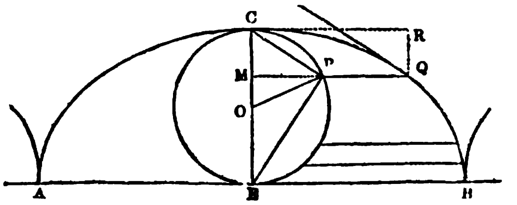
CYCLOGRAPH, or ARCOGRAPH, is an instrument for drawing arcs of circles without centres, and is used in architectural and engineering drawing, when the centres are too distant to be conveniently accessible. One such contrivance, which however does not produce perfectly circular arcs, is noticed under Compasses. Bricklayers and masons, when they wish to strike an arc for the tops of doors and windows, have recourse to a very simple mode of accomplishing the object, by driving a nail into the wall at each extremity of the intended arc, and then nailing two straight laths or rods together at such an angle that while their external sides or edges are in contact with the nails driven in the wall, their apex or meeting point shall touch the crown of the required arch. A tracing point in the apex will then describe the required arc. The same plan may be adopted in drawing on paper, substituting pins for the nails, and a piece of stout cardboard, cut to the required angle, for the laths. Mr. Rotch's Arcograph, described in the 'Transactions' of the Society of Arts, vol. xxxix. pp. 49–51, is an instrument consisting of two rules connected together by a joint which forms a socket for a pencil, and furnished with two quadrant-shaped pieces of brass, sliding upon one another, by which the rules may be set to any required angle, and secured by clasps. This instrument is used in the same way as the laths above described, and it affords the means of measuring, by the graduation of one of the quadrants, the degrees contained in the arcs described by it. Mr. Alderson's *Curvilinead*, described in the forty-fourth volume of the same work, pp. 151–156, is another instrument on the same principle, but of more perfect construction, in which the pencil may be projected beyond the apex of the angle for the purpose of drawing a second arc parallel with the first. This second arc is not mathematically correct, but, when on a small scale, it is sufficiently so for all ordinary purposes.

The *Centrolinead* of Mr. Peter Nicholson, described in the thirty-second and thirty-third volumes of the 'Transactions' of the above Society, pp. 67-70 and 69-81, is an instrument acting on the same principle, although its chief use is, not as a cyclograph, but as an instrument for drawing lines converging to a distant and inaccessible point. It may be compared to a T-rule in which the transom consists of two pieces adjustable to any required angle with each other, and the centre of which, answering to the apex of the cyclographs above described, is precisely on a line with the fiducial or drawing edge of the stem or long limb of the rule. The instrument being once adjusted to the required angles, and having its angular transom laid against two fixed pins, just like the angle of a cyclograph, any number of converging lines may be drawn by it as readily as parallel lines drawn by a common T-rule, with its transom sliding against the edge of the drawing-board.

Another instrument rewarded by the Society of Arts, and described in the thirty-fifth volume of their 'Transactions,' pp. 109-112, under the name of a *Curvograph*, was contrived by Mr. Warcup for copying or transferring curved lines, or describing them originally, of any required curvature, by means similar to those adopted in the instrument represented under Bevel. The adjustable ruler itself consists of a thin pliable slip of whalebone, and the adjusting ribs, answering to the screws *ff*, in the figure above referred to, instead of being screwed, are merely secured in any required position by the pressure of wedges acting upon small pieces of cork inserted in the ruler or stock through which they pass.

CYCLOID (κυκλοειδής, like a circle), a name very incorrectly given to the curve which is traced out by any point of a circle rolling on a straight line. Thus while the wheel of a carriage revolves, each nail on the circumference describes a succession of cycloids; more correctly, a succession of branches of *one cycloid*. We might also here describe the various curves made by the points of circles which roll inside or outside of other circles, &c. &c. But as the cycloid stands apart from all the rest, both in simplicity and historical notoriety, we shall here confine ourselves to this one curve alone, and refer the rest to the head Trochoidal Curves.

If we suppose a circle to roll on a straight line, it is obvious that the centre will advance in every moment through a length equal to the portion of the circumference which is brought in contact with the line on which the circle rolls. That is,



supposing C, the point now highest on the circle, to be the one whose path is to be traced, then, by the time the mere rotation would have brought this point to P, the whole system will have been carried forward through a length PQ equal to the arc CP. Hence follows a very simple mode of conceiving the form of a cycloid: at every point P imagine a line PQ parallel to AB and equal to the arc CP; the extremities of all these lines will be in the cycloid. The arc AC, through which the point on the circle rises from the line AB to its highest position, is similar and equal to the arc CB through which it descends. In the diagram we see small parts of the preceding and succeeding cycloids.

The principal properties of the cycloid are as follows:—

1. PQ is equal in length to the *arc* CP.
2. The tangent at Q is parallel to the *chord* CP.
3. The arc CQ is twice the chord CP, and the whole arc ACB is four times CB, the diameter of the generating circle.
4. Complete the rectangle CQR; the area CQR is equal to the

circular area O P M, and the whole area A C B is three times that of the generating circle.

5. The curvature at Q is the same as that in a circle whose radius is twice E P, and the involute and evolute (see these terms) of a cycloid are both cycloids of the same magnitude.

6. If the figure be reversed, so that C is the lowest point of the cycloid, and A and B the highest points; then, no friction being supposed, and the cycloid being of resisting matter, a small weight placed at Q will take the same time to slide to C, whatever the point Q may be. Hence all the arcs of the cycloid are said to be *synchronous*.

6. On the same supposition as in the preceding, a weight will slide from B to Q in a shorter time than in any other curve which can be drawn between B and Q. Hence the cycloid is called the *brachystochron*.

Let θ be the angle C O P (in theoretical units) [Angle], $CM=x$, $MQ=y$, $OP=a$, then we have the following equations:—

$$x=a\,(1-\cos\theta)$$
$$y=a\,(\theta+\sin\theta)$$

from which the properties of the curve may be deduced.

If, instead of measuring P Q from P, we had carried it forward from M, then Q would have described a curve known by the name of the *companion to the cycloid*, but which is in truth a *curve of sines*. [Sines, Curve of.]

The history of the cycloid is remarkable from the contests which it produced, and the manner in which the names of Galileo, Descartes, Mersenne, Pascal, Roberval, Wallis, and others, appear in connection with it. But there would be little use in giving an abstract of history on points of no material use, and the interest of which depends on the light in which a detailed account, and nothing less, would place the state of science of the 17th century. Galileo was certainly the first who attempted the investigation of the properties of the cycloid, as appears from a letter to Torricelli, written in 1639. (See Montucla, 'Hist. des Math.' vol. ii. p. 52, &c.)

CYCLOPÆDIA. [Dictionary.]

CYDER. [Cider.]

CYGNUS (the swan), one of the old constellations of Aratus, who refers it to the fable of Leda, as does Hyginus; but the latter gives another fable of the same kind. The bright star (Deneb), α Cygni, may be seen on the meridian at eight o'clock in the beginning of October; the bright stars in Aquila, Lyra, and Cygnus form a remarkable triangle.

The principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
κ	1	6623	4
β^1	6	6690	3
δ	18	6779	3
θ	13	6734	4
γ	37	7022	3
(ι)	41	7067	4
α	50	7171	2
ε	53	7204	3
χ	54	7213	4
υ	58	7277	4
ξ	62	7333	4
ζ	64	7368	3
τ	65	7385	4
σ	67	7398	4
ρ	73	7503	4
π^1	80	7560	4

CYLINDER, in mathematics (κύλινδρος), a name given generally to the surface formed by a straight line which moves parallel to itself, whatever may be the guiding curve; but frequently confined to the common definition, which supposes the straight line to be of finite length, and to move round the circumference of a circle, keeping always at right angles to its plane. We shall extend this a little, and treat of the cylinder which has an oval for its base, and the moving line at right angles to the plane of the base, whence the cylinder is called a *right* cylinder.

The cylinder may be considered as a cone, of which the apex is at an infinite distance; and many of the general notions in the article Cone may be applied to it.

The content of a cylinder (in cubic units) is the number of square units in the base multiplied by the number of linear units in the altitude. Thus the cylinder being circular, the base having a radius of 10 feet, and the altitude being 7 feet, the number of square feet in the base is 100 × 355 ÷ 113, or 314·159, which, multiplied by 7, gives 2199·113, the number of cubic feet in the cylinder. To find the number of square units in the surface, multiply the number of linear units in the circumference of the base by that in the altitude. Thus in the preceding case the number of feet in the circumference of the base is 20 × 355 ÷ 113, or 62·8318, which, multiplied by 7, gives 439·8226, the number of square feet in the cylindrical part of the surface, exclusive of its two terminating planes. [Prism, Subcontrary.]

CYLINDRICAL LENS. [Lens.]

CYMAMETER. This name has been given to a contrivance, registered by Mr. Fenn a few years ago, for making copies of the outlines of capitals, cornices, mouldings, and other architectural figures. Many years earlier, a curious plan was adopted for taking a mould of the human face, by enclosing a large number of thin steel wires in a frame; pressing it gently and gradually, so that one end of every wire should touch the face, and thus form a die or intaglio of wires, the reverse of the face. Mr. Fenn seems to have conceived his cymameter as an extension of this plan. It consists, essentially, of a large number of very thin laths or plates, all of equal length, and placed one on another. When one end of these laths is pressed against a moulding or other device, the other end assumes a corresponding position; the laths which press against a convex surface jut out more at the other end than those which press against a concave surface; insomuch that the outer extremities of all the laths form collectively a type of the moulding or device.

CYMBALS (κύμβαλον), metallic musical instruments of percussion, which are traceable to the remotest ages of antiquity, and, with no great change in form, are still used by the moderns. They are always in pairs, are made of brass, and, according to Greek sculptures and medals, anciently took, as their name imports, a more cup-like shape than at present. Servius says that the cymbals were consecrated to Cybele—that is, were employed by her priests—because they represented the two celestial hemispheres which surround the earth. They are now nearly flat, about twelve inches in diameter, the central part sunk in, and at the back of the sunken portion is a strap, by which each instrument is held. The sound is produced by striking them more or less violently together, and in the open air they produce a very martial effect, but are entirely out of place in the theatre and concert-room. Into the latter, indeed, they have not yet often intruded, but in modern theatrical music they take a prominent part when the composer has to make up by noise what he wants in genius and taste.

CYMENE. [Camphogen.]

CYMIDINE ($C_2H_{15}N$). An artificial organic base, analogous to aniline. It may be formed by the action of sulphide of ammonium upon nitrocymole ($C_{20}H_{13}NO_4$).

CYMI'NUM CYMI'NUM, *Medical Properties of*. This annual umbelliferous plant (the generic name of which is most commonly spelt Cuminum, which mode is correct if it be a mere Latinised form of the Arabian word Qamoùn, but incorrect if it be a reduplication of the Greek κύμινον) is native in Egypt, Æthiopia, &c., and was cultivated by the ancients in Palestine, as it is by the moderns in Malta, Sicily, and India. The fruit (improperly termed seed) is the officinal part. Externally it is of a grayish yellow colour, and is larger than those of caraway or anise. The seed within more readily separates from the pericarp than happens with most other umbelliferous fruits. It is distinguished from others by having the ridges (juga) prolonged into a point at the summit of the fruit. The primary ridges are five, filiform, and furnished with very fine prickles; the secondary are four, prominent and prickly. Beneath each of these is one vitta. The odour is strong, aromatic, and rather unpleasant; the taste is warm, bitter, and disagreeable. The odour and taste are mainly due to a volatile oil which is more abundant in this fruit than in most umbelliferous plants: one pound yields half an ounce of this oil, according to some; while ten pounds yield only three ounces and a half, according to others. Notwithstanding this large quantity of oil, the fruits are frequently eaten by insects. The oil is pale yellow, but speedily becomes brownish, very limpid, of a specific gravity of 0·975. This consists of two distinct oils, one a carbo-hydrogen, belonging to the terebinthinate series; the other an oxygenated oil, or hydruret of cumyl. (Pereira.) The odour is, like that of the fruit, disagreeable, and the taste is acrid. When old it becomes acid, and according to Chevallier contains succinic acid.

The disagreeable odour of cumin seems to have gradually discarded it from medicine for man, and restricted its use to veterinary medicine. Its employment in this way may be a relic of its ancient repute, for the Israelites esteemed it highly as a remedy for cattle after the bites of insects. (Lady Callcott's 'Scripture Herbal,' p. 124.)

Still it is a potent carminative, and was esteemed by Cullen the best of this class of remedies, a preference to which the very large portion of essential oil it contains justly entitles it. It was reported also discutient and diuretic. In the former quality it was employed as a plaster. It was reckoned one of the semina 4 calida majora. In the north of Europe it is still much used as an addition to bread and ragouts. It enters into the composition of many curry-powders, but should be introduced into these in very small quantity. In Germany a sort of liqueur or aromatic water is distilled from the fruits, useful as a carminative, called kummel-wasser. The seeds of the nigella sativa are, in the same country, called black cummin.

CYMOLE ($B_{20}H_{14}$). This substance, met with in oil of cumin, and which also occurs in coal-tar oil, is further formed by the action of anhydrous phosphoric acid, or of chloride of zinc or camphor.

$$\underbrace{C_{20}H_{16}O_2}_{\text{Camphor.}} = \underbrace{C_{20}H_{14}}_{\text{Cymole.}} + 2HO$$

It is a colourless liquid of an agreeable odour. It is lighter than water, and boils at 347° Fahr. Fuming sulphuric acid forms with it a copulated acid.

Sulphocymolic acid ($C_{20}H_{14}S_2O_6$). When heated with moderately strong nitric acid it is changed into toluic acid ($C_{16}H_8O_4$) and nitroluic acid ($C_{16}H_7(NO_4)O_4$). By the action of a mixture of sulphuric and nitric acids, it is converted into *binitrocymole* ($C_{20}H_{12}(NO_4)_2$) a substance which crystallises in iridescent rhombic plates.

CYNAPINE, an alkaloid said to be found in the false parsley (*Æthusa cynapium*). Its composition is unknown.

CYNENE ($C_{24}H_{18}$). A hydrocarbon oil, obtained by distilling the essence of semen-contra (*Artemisia castra*) from anhydrous phosphoric acid. It is a very fluid colourless oil, soluble in ether, but insoluble in water. Its specific gravity is ·825, and it boils about 345° Fahr.

CYNICS, the name of a sect of Greek philosophers who were produced by the school of Socrates, and were so called according to one interpretation of the word (*κυνικοί*, dog-like) from their snarling disposition, though it is possible that the name may have been derived from the gymnasium called Cynosarges, in which Antisthenes, the founder of this school, used to lecture. [ANTISTHENES, in BIOG. DIV.] Their doctrines were the exact opposite of those of the Cyrenaics, who were also an offshoot of the Socratic philosophy. [CYRENAICS.] They held that virtue was not only the highest but the only object at which men ought to aim, and that most of the sciences and arts, as they do not tend to make men virtuous, but sometimes on the contrary interfere with the attainment of it, are unprofitable and pernicious. The true philosopher, according to their notions, was he who could discard all the comforts and charities of life and triumph over his bodily wants, so as to be enabled to live only for virtue without any interruptions either to the contemplation or the practice of it. The result of these principles was great strictness of morals, and voluntary penances worthy of the fanaticism of an eastern dervise; and as long as these characteristics were coupled with ability in the professors and consistent philosophy in what they taught, the sect maintained its place by the side of other philosophical systems, and some members of it, for instance Antisthenes and Diogenes, deserved and obtained great celebrity. [DIOGENES, in BIOG. DIV.] At length, however, the morality of the Cynics degenerated into the most shameless profligacy (see the case of 'Crates and Hipparchia' in Diogen. Laërt. vi. § 97), and they became so disgusting from their impudence, dirty habits, and begging, that they ceased to be regarded with any respect, and the sect dwindled away into obscurity. Of their speculative opinions we know very little: indeed it does not appear that they had any theories, except on the science of logic. The great merit of the Cynic philosophy was that it paved the way for the establishment of Stoicism, which succeeded and superseded it, just as the philosophy of Epicurus supplanted that of Aristippus. The connection of this school with the philosophy of Socrates appears to have consisted in their developing the idea of science as applied to morality (to which object the labours of Socrates were mainly directed), but they did so to the exclusion of all those other principles which Socrates admitted as useful adjuncts, and his sneers at the austerity and affected negligence of Antisthenes may be taken as a proof of the low opinion which he entertained of this narrow application of his doctrines. (Diogen. Laërt., vi., § 8; ii., § 36.) The classical reader will find in Lucian's 'Cynicus' an attempt to justify some of the peculiar views of this school, especially in regard to their neglect of the conveniences of life, though it is not to be supposed that Lucian was inclined to the Cynical philosophy, for he elsewhere ridicules it. (See the 'Lapithæ' and the 'Vitarum Auctio.' See also Ritter's 'Geschichte der Philosophie,' Hegel's 'Geschichte der Philosophie,' and G. H. Lewes's 'Biographical History of Philosophy.')

CYNODIN. A non-azotised crystallisable body of unknown composition, found in dog-grass (*Cynodon dactylon*).

CYNOSU'RA (*κυνὸς οὐρά*, the tail of the dog), a name given to the lesser Bear. According to Aratus and Hyginus, Cynosura was one of the nymphs of Mount Ida, who nursed Jupiter. But it is at least as probable that before the Greeks adapted their mythology to the constellations, they had from some oriental source the habit of figuring Ursa Minor as a dog, and that the tail of the dog was the pole star. [URSA MINOR.] Many persons may probably know this word only from the two lines of Milton's 'Allegro'—

> Where perhaps some beauty lies,
> The Cynosure of neighbouring eyes.

These lines may have puzzled some readers, though the reference to the pole star and the property of the magnet gives the image a degree of fitness for poetry which the etymology of the word alone would hardly suggest.

CYRAMETURIC ACID. [CYANOGEN.]

CYRENA'ICS, a school of philosophers among the Greeks, who derived their name from the birth-place of their founder Aristippus. [ARISTIPPUS, in BIOG. DIV.] Like the Cynics, their doctrines were a partial development of those of Socrates; but the view they took of their predecessor's philosophy was quite different from the Cynical. [CYNICS.] The only particular in which the two sects agreed with the original system and with one another was that they all three made virtue consist in knowledge; in other words they were all three attempts to awaken and develop the idea of science; but while the Cynics considered all sublunary enjoyment and most branches of knowledge as impediments to the knowledge, and consequently, according to Socrates, to the practice, of virtue, the Cyrenaics, on the other hand, were not contented with the mere knowledge of the good as a general term, but sought for it in the separate particulars, and deemed him to have performed his proper functions most consistently with his nature who had succeeded in amassing the greatest number of particular good things. In regard to the idea of science, they did not look upon it as a speculative conception, but as a merely empirical result, as the aggregation of successive experiences; in other words, not as an intuition but as a combination of perceptions; and while Plato, and in some measure the Cynics also, placed the *summum bonum* in the attainment, by means of dialectics, of the abstract idea of the good, the Cyrenaics placed it in the collection of the greatest number of agreeable perceptions, and the true philosopher, according to them, was one who actively, methodically, and successfully carried on the pursuit of pleasure. Consequently, as agreeable perceptions were continually to be sought as good and the contrary to be avoided as bad in themselves, perception of sensible objects became the criterion of all knowledge and the object of all action, and therefore truth both theoretical and practical. (Sextus Empir. 'adv. Mathematicos,' vii., § 191–200.) The chief successors of Aristippus were Theodorus, Hegesias, and Anniceris. Theodorus perceived the necessity for some principle, in addition to the mere collection of agreeable sensations; for without some effort of the understanding to determine which of many gratifications was to be preferred, it would be impossible, he thought, to obtain the maximum of gratification; and he therefore set the understanding over the senses as a regulating and restraining faculty. He is said to have been banished from Athens for denying the existence of the gods. (Diog., Laërt., ii., § 97.) Hegesias, following in the steps of Theodorus, insisted still more than he did upon the inadequacy of the senses as the criteria of the desirable, and at last even went so far as to assert that nothing was in itself either agreeable or the contrary, and that life and everything in life should be a matter of indifference to the wise man. In this assertion of the principle of indifference he made an approach to the doctrines of Epicurus and the Stoics in the point in which those two opposite systems met. Cicero tells us ('Tuscul. Disput.,' i., c. 34) that his book called ἀποκαρτερῶν caused so many suicides that he was forbidden by one of the Ptolemies to lecture on the worthlessness of life. In the philosophy of Anniceris and his followers the original principles of the Cyrenaics were quite lost, and though he also, in a popular way recommended the pursuit of the agreeable, he denied that it depended in any way upon mere sensible impressions, for that the wise man might be happy in spite of all annoyances; that friendship was to be sought, not for the sake of any immediate advantage to be derived from it, but on account of the good-will which it generated; and that for a friend's sake a man should encounter even annoyances and troubles. (Diog. Laërt. ii., § 96, 97.) These are the doctrines of a mere popular morality, and can hardly be ascribed to one school more than to any other. It will be remarked by every one that the original tenets of this school were very similar to those of Epicurus; indeed, with the exception of the atomic system which he borrowed from Democritus and Leucippus, the two systems differed only in this: the Cyrenaics placed the great object of man in the positive and active pursuit of the agreeable, while Epicurus made it consist in a perfect rest of mind and in freedom from pain; for he considered the agreeable as something merely negative, as the pleasing harmony produced by exemption from all passion and appetite. The philosophy of Epicurus may therefore be considered as the successor, in one point of view, of the system of Aristippus.

(See also Ritter's *Geschichte der Philosophie*; Hegel's *Geschichte der Philosophie*; and G. H. Lewes's *Biographical History of Philosophy*.)

CYSTIN ($C_{12}H_{12}N_2O_8S_4$?), *Cystic Oxide*. A crystalline substance constituting a very rare form of human calculus. It is neutral, fusible by heat, and furnishes by destructive distillation a very fetid ammoniacal water. It is insoluble in water and in alcohol, but the fixed alkalies and their carbonates dissolve it readily. Cystin is also soluble in many of the acids.

CYTISIN. A non-azotised bitter substance, extracted from the *Cytisus laburnum*. It appears to be identical with cathartin. [CATHARTIN.]

CZAR, or TZAR, the Russian title of the monarch of Russia. Some have supposed it to be derived from Cæsar or Kaisar, but the Russians distinguish between Czar and Kesar, which last they use for emperor. The sovereign of Russia styles himself also Autocrat of all the Russias. It is only since the time of Peter the Great that the title of emperor has been given to him by the senate, and afterwards by the other courts of Europe. Before Peter's time, the sovereign of Russia was styled grand duke in European diplomacy. The consort of the czar is styled czarina.

D

D, which occupies the fourth place in the Hebrew alphabet and those derived from it, is the medial letter of the order of dentals or palato-dentals. It readily interchanges with those of the same organ. The German language and the English offer an abundance of examples.

1. *D* in German corresponds to *th* in English, as *dein*, thine; *denk-en*, think; *du*, thou; *dieb*, thief; *donner*, thunder; *dorn*, thorn; *durch*, through; *tod*, death; *bruder*, brother; *erde*, earth; *leder*, leather; &c. And on the other hand, *th* in German, which however is not pronounced as among us, corresponds to *d* in English, as *thau*, dew; *thal*, dale; *thaler*, dollar; *thu-n*, do; *that*, deed; *theil*, dole and deal; *roth*, red; *noth*, need; *muth*, mood.

2. *T* in German to *d* in English, as *tag*, day; *taub*, deaf; *taube*, dove: *tief*, deep; *traum*, dream; *tod*, death; *brot*, bread; *breit*, broad; *wort*, word; *bart*, beard.

3. *D* in Latin to *z* or *ss*, or *s* final in German, and *t* in English, as *decem*, *zehen* or *zehn*, ten; *digitus*, *zehe*, toe; *duo*, *zwey*, two; *dingua*, (the same as *lingua*), *zunge*, tongue; *dens* (*dent*) *zahn*, tooth; *cor* (*cord-is*), *herz*, heart; *duc-ere*, *zieh-en*, tug: *doma-re*, *zahm-en*, tame; *sud-or*, *schweiss*, sweat; *pes* (*ped-is*), *fuss*, foot; *ed-ere*, *ess-en*, eat; *clud-ere*, *schliess-en*, shut; *od-it*, *hass-en*, hate; *quod*, *was*, what; *id*, *es*, it; *grandis*, *gross*, great.

4. *D* is interchangeable with *l*, and this most freely. Compare the Greek forms Οδυσσευς, Πολυδευκης, δαψιλης, δακρυ-ω, δε-ω, δολιχος, with the Latin *Ulixes*, *Pollux*, *lapsilis*, *lacruma*, *liga-re*, *longus*. In the Greek language itself compare δειδω with δειλος, δαλος with δᾳς (δᾳδ-ος); and in the Latin, *sella*, *scala*, *mala*, *ralla*, with the verbs *sede-o*, *scand-o*, *mand-o*, *rad-o*. *Vesidia* and *Digentia*, two small streams of ancient Italy, are now called respectively *Versiglia* and *Licenza*. So the Italians say either *edera* or *ellera* for ivy; and the Latin *cauda*, a tail, is in Italian *coda*, in Spanish *cola*. But one of the most remarkable instances of this change exists in the words *eleven* and *twelve*, in both of which the *l* has grown out of a *d* in *decem*. In the same way, while the Greek has δεκα for ten, the Lithuanian prefers *lika*; and of two Sanscrit dialects, one has *dasan*, the other *lasan*, for the same numeral. The people of *Madrid* call themselves *Madrilenos*. The language of *Madagascar* is *Malagash*.

5. *D* attaches itself to the letter *n*. Thus we find Gr. τειν-ω, and Lat. *tend-o*, stretch; Lat. *canis*, Eng. *hound*; Lat. *sonus*, Eng. *sound*; Lat. and Gr. root μεν or *men*, Eng. *mind*; Ger. *abend*, Eng. *even* or *even-ing*; Ger. *donner*, Eng. *thunder*; Ger. *niemand*, Lat. *ne-mon*, Eng. *no-man*. And our English term *husband*, is a corruption of *house-man* (Lat. dominus). This *d* is particularly apt to insert itself after an *n* when an *r* follows. Thus from the Latin *ciner-is*, *gener*, *tener*, come the French *cendre*, *gendre*, *tendre*. And the latter language has the futures *viendrai*, *tiendrai*, where analogy would have led to *venir-ai*, *tenir-ai*.

6. *Di* before a vowel is changed into a *g* or *j*, as *Dianus* or *Janus*, the god of light (dies) in Roman mythology; *Diana* or *Jana*, the goddess of light. So *Diespiter* and *Jupiter* are the same name. The Latin *hodie* is in Italian *ogge*. Sometimes a *z* is preferred to a *g*, especially in the Greek, Italian, and German languages. In the Greek, for example, ζα is used for δια; hence ζαω, *vivo*, and διαιτα, are connected, and the same town on the African coast is called indifferently *Hippo Zarytus* or *H. Diarrhutos*. So in England we write the name of a certain town *Odiham*, and call it *Ojam*.

7. *Du* before a vowel is changed into *b* or *v*. [See B.] With this principle is connected the change of *d* into *v*, in the words *suavis*, *suadeo* and ἁδυς, *clavis* and *claudo*, and the river *Suevus* or *Oder*.

8. Instances occur where *d* is interchanged with both the other medials; with *b*, as in Latin *barba*, *verbum*, English *beard*, *word*; with *g*, as in the Greek Δημητηρ from γη μητηρ, πηδος, "the beech," as well as φηγος, and in the two names of the African city, Καρχηδων and *Carthago*. One may often hear in the mouths of children *dood* for *good*, and *do* for *go*.

9. *D* when flanked by vowels often disappears in the transition of words from Latin into French. Compare *Melodunum*, *Ludovicus*, *vadum*, *vādis*, *medius*, *fides*, *nudus*, *cauda*, *assidere*, *videre*, with *Melun*, *Louis*, *gué*, *vas*, *mi*, *foi*, *nu*, *queue*, *asseoir*, *voir*.

For the forms of the letter D see ALPHABET.

D as a Roman numeral signifies five hundred. It is more correctly written IↃ. [NUMERALS.]

DA CAPO ("from the head," or "beginning"), an Italian musical term, signifying that the first part, or strain, is to be repeated, and to conclude at the sign of the pause (𝄐), or at the word *fine*. The phrases in use are, *Da Capo al fine*, and *Da Capo al segno*; that is, "From the beginning (or over again) to the *fine*," or "to the sign." This term is abbreviated by the letters D. C.

DACTYL is the name of a metrical foot consisting of a long and two short syllables, as the Latin word *littora*; or of an accented syllable followed by two unaccented, as *gallery*.

DACTY'LICS. To this term belong all those metres which consist of a repetition of dactyls or equivalent feet. The long syllable may be the first in the line, as it is in the heroic verse of Homer; or it may be preceded by one or two short syllables. Thus the modern anapæstic verse is strictly a dactylic metre, as—

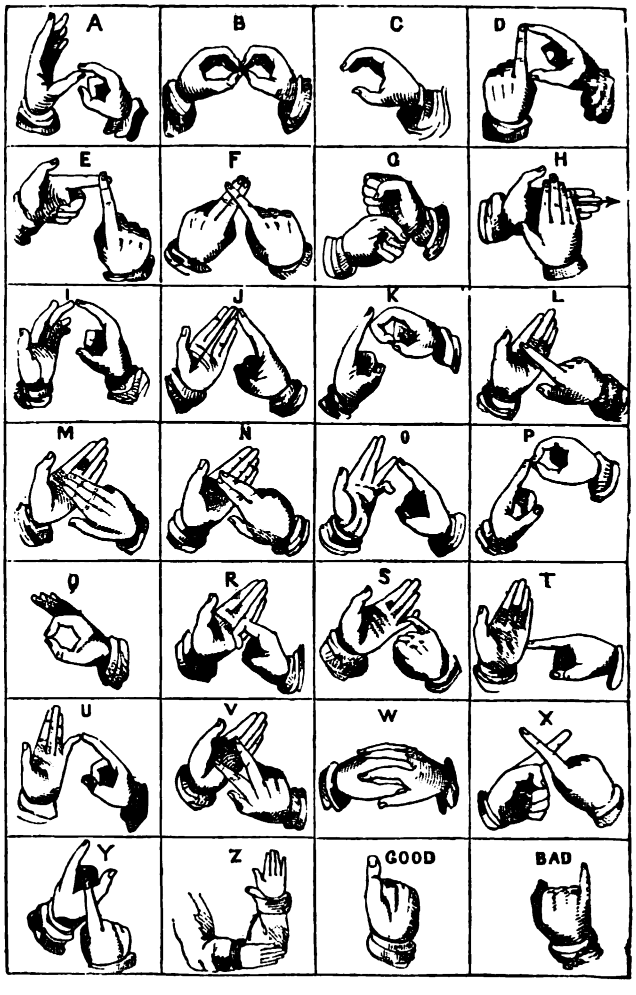
> "If he ha'd any fau'lts, he has le'ft us in dou'bt."

Of the dactylic metres the most common are the hexameter, which, as its name implies, consists of six feet [HEXAMETER], and the pentameter, of five feet.

The dactylic metre often alternates with trochaic measures. Such is the case in the sapphic and alcaic stanzas.

DACTYLO'LOGY. The simple art of communicating ideas by spelling words with the fingers is called dactylology. The positions which the fingers are made to assume correspond to the alphabetic characters of a language, and the series of alphabetic signs is perhaps better known under the name of the manual alphabet. The chief, and the most useful application of dactylology is in the instruction of the deaf and dumb. In the various institutions for this class of persons, dactylology is almost universally employed. The letters may be formed by the two hands, or with only one hand: a two-handed alphabet is used in the English institutions; on the continent of Europe, and in America, the one-handed alphabet is employed. Either of them may be learned by an hour's practice; they are often taught to the deaf and dumb, in conjunction with the written alphabet, in a few days.

TWO-HANDED ALPHABET OF THE DEAF AND DUMB.



Dactylology must not be confounded with the natural language of the deaf and dumb, which is purely a language of mimic signs. We mention this because some persons have misunderstood the office and overrated the value of finger-talking; imagining that all deaf and dumb persons naturally understand language, and converse with their fingers, and that, by acquiring the manual alphabet, they can communicate with them. Such persons should bear in mind that the deaf are shut out from all spoken languages; that before they can use or understand a written or spoken language, they must learn it; and that such an acquirement is made, under their disadvantages, by a very slow process. To the deaf and dumb under instruction, dactylology is useful as a means of communication between them and their teacher; at first, in such select language as the pupil understands, or as may be readily explained by mimic signs or other auxiliaries. As the pupil advances in the knowledge of words and their collocations, this mode of communication becomes more satisfactory, and at length he can use it to converse on all ordinary subjects with the accuracy of writing and with much greater rapidity.

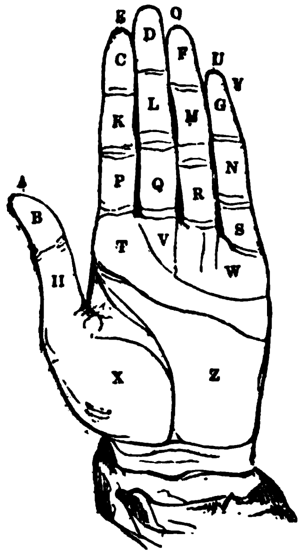
Degérando has clearly and fully explained the use and value of this very simple art. ('De l'Education des Sourds-Muets,' Paris, 1827.) He says dactylology is to alphabetic writing what that is to speech. Formed upon writing as its model, it represents it precisely as writing represents words. But in this connection between dactylology and writing, the reciprocal utility of the two orders of proceeding is at the same time the reverse of what we have remarked in the connection between writing and speech. In fact, the office of dactylology consists in giving to writing that moveableness which speech enjoys, and which the first loses in the fixedness of depicted characters. Dactylology is writing set free from its material dress, and from those conditions necessary for the employment of the pen or pencil; it carries with itself these instruments; it is thus ready in all familiar conversations; it affords help at all times and in all places. It is thus that dactylology is little more than a toy for those who already possess, in speech, a means of communication more easy and more appropriate to all circumstances. It is thus also that it becomes an essential resource to those who are deprived of speech, to whom it renders a portion of those advantages, supplying for them writing, and giving it in some manner a new extension. However, dactylology is far from affording all the advantages of speech, while it loses a portion of those which are peculiar to the privilege of writing. On the one hand it is much less rapid than speech; it is unfurnished with that expression which belongs to the human voice—of that infinite diversity which the soul finds within for pourtraying all the sentiments which affect it; it has nothing of that harmony, that secret charm, that power of imitation of which speech is so capable; its employment, besides, obliges the suspension of all business and all action. On the other hand, it has none of that durability which renders writing so favourable to the operations of reflection; it is not able to exhibit its signs but after a successive manner; it cannot preserve in composing, as writing does, those vast pictures which the inventive faculty embraces simultaneously, and subsequently surveys, in every sense, with perfect liberty. Dactylology shares in some of the inconveniences of speech, and in some of those of writing; it is as fugitive as the first, it is as complicated in its forms as the second. (Vol. i., pp. 259, 60.)

The manual alphabet has been employed as a medium of intercourse between the deaf and dumb, and blind persons; it is also commonly used by the former when they have to converse in the dark. As the art addresses itself to the sense of touch, as well as to that of sight, it is easy to touch another person's hands, who is acquainted with the hand alphabet, in such parts or positions as to enable him to read the words or sentences thus conveyed. Bulwer, one of the earliest writers on the instruction of the deaf [BULWER, in BIOG. DIV.], was fully aware of the advantage of manual alphabets in their instruction; and it seems strange that he did not invent one, or ascertain and make known the merits of one, of which he thus writes:—

"A pregnant example, of the officious nature of the touch in supplying the defect or temporall incapacity of other senses, we have in one Master Babington, of Burntwood, in the county of Essex, an ingenious gentleman, who, through some sicknesse, becoming deaf, doth, notwithstanding, feele words, and, as if he had an eye in his finger, sees signes in the dark; whose wife discourseth very perfectly with him by a strange way of arthrologie, or alphabet contrived on the joynts of his fingers; who, taking him by the hand in the night, can so discourse with him very exactly; for he feeling the joynts which she toucheth for letters, by them collected into words, very readily conceives what she would suggest to him." ('Chirologia, or the Natural Language of the Hand,' p. 106.)

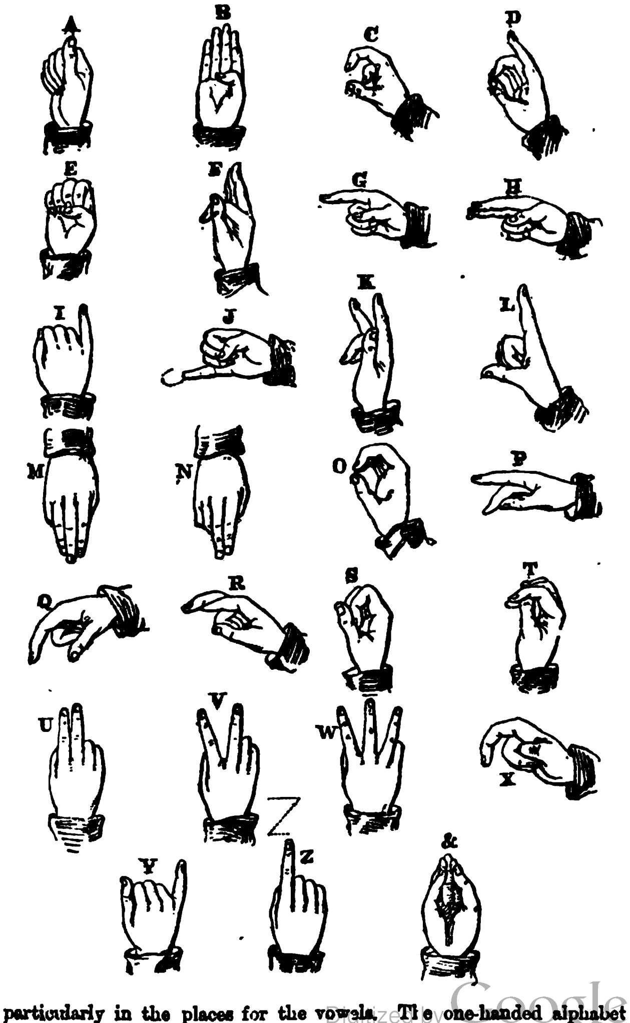
Perhaps the first manual alphabet which was published in England was that of Dalgarno, the most intelligent author on the subject of the instruction of the deaf and dumb next to Bulwer; he published it in 1680. As few copies of his work are now to be met with, we shall give his hand-alphabet, and accompany it by as much of his own explanation as seems necessary for understanding his views on dactylology. "After much search and many changes, I have at last fixt upon a finger or hand-alphabet according to my mind; for I think it cannot be considerably mended, either by myself or any other (without making tinker's work), for the purposes for which I have intended it; that is, a distinct placing of and easy pointing to the single letters; with the like distinct and easy abbreviation of double and triple consonants."

"The scheme (I think) is so distinct and plain in itself, that it needs not much explication, at least for the single letters, which are as distinct by their places as the middle and two extremes of a right line can make them. The rules of practice are two. 1. *Touch the places of the vowels with a cross touch with any finger of the right hand.* 2. *Poynt to the consonants with the thumb of the right hand.* This is all that I think to be needful for explaining the scheme, so far as concerns the single letters."



This was probably the finger-alphabet from which our present two-handed one was derived; some similarities may be traced in them, particularly in the places for the vowels. The one-handed alphabet

ONE-HANDED ALPHABET FOR THE DEAF AND DUMB.



was invented in Spain, and appears to have been first published in Bonet's work. [BONET, in BIOG. DIV.]

At a conference of principals of institutions for the deaf and dumb, held at the Yorkshire Institution at Doncaster, on July 28th, 1852, a paper was read by Mr. Hopper, headmaster of the institution for the deaf and dumb at Birmingham, 'On the One-Handed Alphabet,' in which he thus stated its claims for more general adoption :—

"It appears to possess every advantage that can be claimed for the two-handed alphabet. The various positions by which it represents the letters can be assumed as rapidly, and with as much facility, as those employed in the two-handed method. It has besides many advantages over its rival. It is more distinct. The upright, downward, and horizontal positions of the hand, enable one to distinguish easily several of the letters at a distance. The signs for the vowels being as distinct as those for the consonants, prevents the confusion occasioned by the difficulty of observing which finger has been touched in rapid spelling with both hands. By using the right hand, when conversing with a person placed on one's left, and *vice versâ*, what is spelled can be easily read by those to whom it is addressed; while, in employing both hands, the positions of the fingers are less obvious to the person spelled to than to the person who spells. The employment of one hand only, is in itself a great advantage; for the other hand is left at liberty to hold an umbrella, the reins in driving, and to perform a number of offices that it would be tedious to enumerate. In walking, besides allowing those in conversation to be linked, it does not attract the attention of strangers so much as the two-handed system of spelling. In sickness, too, it requires comparatively very little effort to hold out one hand, and to spell with it. I have found that our deaf-mutes, though more practised in the two-handed method, invariably use the other alphabet when confined to bed."

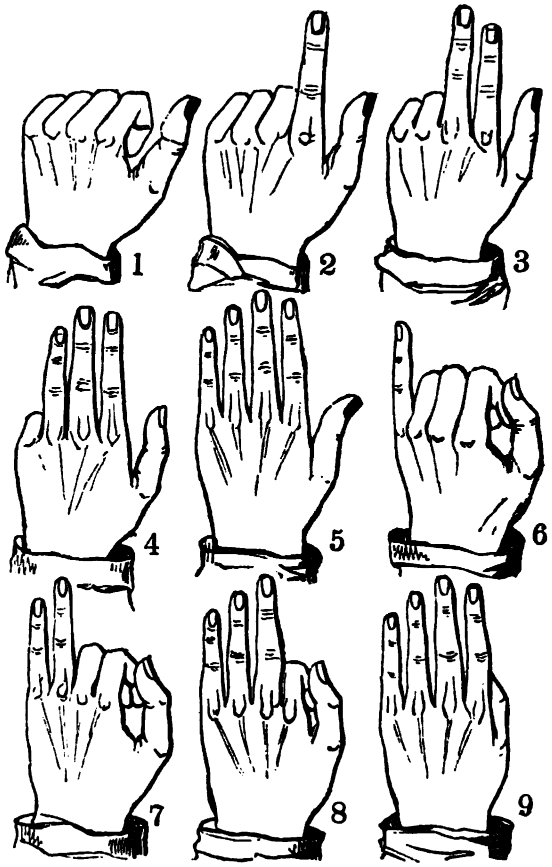
"Should it be considered by the teachers present desirable to substitute the one-handed alphabet for the alphabet now generally used, I would suggest that the greatest possible uniformity, both as to the positions of the hand and of the fingers should be observed."

A short discussion followed the reading of the paper from which the above extracts are given, which concluded by the expression of a unanimous opinion, that it would be desirable to accustom the pupils in all the institutions to the use of both the manual alphabets.

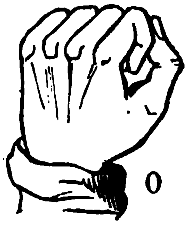
A dactylology of syllables has been sometimes employed in the instruction of the deaf and dumb. This was one of the means adopted by Pereire, who lived in the middle of the 18th century, and who was more successful in imparting a knowledge of language to his pupils than any teacher who has since cultivated this difficult art. But his modes of teaching were a mystery which he always refused to divulge, and they were lost at his death. In more recent days, M. Recoing has employed syllabic dactylology in conjunction with stenography, and by these means, combined with others more commonly pursued, he conducted the instruction of his own deaf and dumb son with that success which enabled him to convey to his son the words of a speaker as rapidly as they were uttered. M. Recoing published two works on this subject at Paris, in the years 1823 and 1829. A system of alphabetic and syllabic-dactylology was also published by Dr. Deleau, the younger, in 1830.

There remains to be noticed another application of finger-language which, in the instruction of the deaf and dumb, is next in importance to alphabetic signs; it is in the designation of numbers, and in the employment of the fingers in the first rules of arithmetic. The ten fingers are the most ready and natural abacus, as they are doubtless the most ancient. That they should early come into use for exhibiting numbers, especially where speech was wanting, may be readily supposed. The only system of manual notation which deserves that name is the one which we shall now describe. It is used in several of the American and English institutions for the deaf and dumb; we consider it perfect, and we believe it has never before appeared in any English publication. Mr. David Seixas, of Philadelphia, improved the Abbé Sicard's signs for numbers, and his plan was used in the institution for the deaf and dumb in that city. The following system was invented by Mr. O. Stansbury, a former superintendent of the New York Institution; it has received a few, perhaps unimportant, modifications, and by it any amount of numbers may be expressed. One hand only, the left is used, and the pupil's right hand is thus left at liberty to record his calculations upon his slate. The nine digits are represented one after another by elevating the fingers of the hand successively, as represented in the annexed illustration.

The thumb represents *one*, the other fingers being closed, the index finger is added for *two*, the middle-finger is raised for *three*, the ring-finger is added for *four*, and the open hand represents *five;* the little finger alone is raised for *six*, the ring-finger is added for *seven*, the middle-finger for *eight*, and the fore-finger is raised to the others for *nine*. Thus far for units. To indicate tens, the position of the hand is changed from perpendicular to horizontal; the thumb is pointed forwards for ten, the thumb and fore-finger for twenty, and so on to ninety. Hundreds are pointed downwards; thus the thumb, fore-finger, and middle-finger pointed downwards represent 300. If 572 be the number to be designated, three positions of the hand are required; the five fingers are pointed downwards for 500, the little-finger and ring-finger are pointed forwards for 70, and the thumb and fore-finger are held upright for two. During these changes the hand is kept in front of the body. To represent thousands, the left hand is placed across the body towards the right shoulder, and the signs which were used in front for units, in this situation, represent thousands; keeping the hand in the same situation and pointing forwards or downwards, tens of thousands or hundreds of thousands are exhibited. By changing the situation of the hand to the left shoulder, and by exhibiting the various positions of the fingers before described, millions, tens of millions, and hundreds of millions are expressed. The same positions, upright, forwards, and downwards, exhibited in other situations, may be applied to the expression of notations to any extent. Though rather complex in description, the whole is most easy and comprehensive in operation. The superiority of this system of manual notation for teaching arithmetic to the deaf and dumb, or for making signals of numbers where silence is necessary, compared with the clumsy resources of figuring the digits in the air, of repetitions of tens by the ten fingers, or even of arbitrary signs, will be at once acknowledged.



The cipher is represented by the closed hand.



The application of this arithmetical dactylology in teaching all the simple rules to the deaf and dumb is very easy; in *addition*, two hands are employed, one for representing the figures added, the other for keeping an account of the results; in *subtraction*, the larger and the lesser number may be shown on the two hands, and the difference afterwards, or the two numbers by one hand, successively, and the difference by the other; in *multiplication*, the factors are shown by different hands by the teacher, and the product required from the pupil; and so with *division*, the product and one factor is shown, and the other factor required. All this can be done without any permanent figuring on slates or tablets, and is better, because more rapid both in explaining principles and in acquiring practice, than the pencil or chalk. At the same time it is chiefly applied in explanations, in early practice, and in mental arithmetic, and can never supersede the usual methods in precision and permanence.

DADO, a term of architecture to express the square die or plinth of the pedestal of a column. It is also used in joinery to express the portion of the wall-decoration of a room comprised between the base-moulding or plinth, and the impost or chair-rail.

DADYL ($C_{20}H_{16}$), is obtained by heating oil of turpentine with lime. [TURPENTINE.]

DAGUERREOTYPE. [DAGUERRE and NIEPCE, in BIOG. DIV.; and PHOTOGRAPHY.]

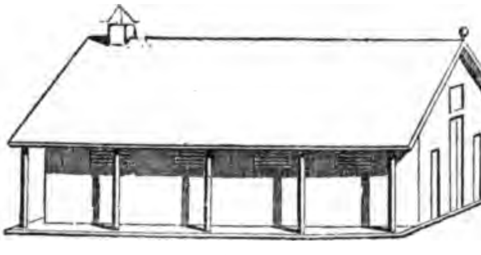
DAHLIN. [INULIN.]

DAIRY, the name usually given to the place where the milk of cows is kept and converted into butter or cheese. The occupation is called *dairying*; and land which is chiefly appropriated to feed cows for this purpose is called a *dairy-farm*.

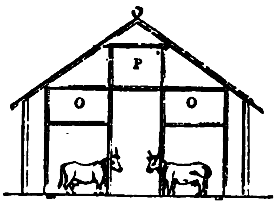
A dairy-house should be situated on a dry spot somewhat elevated, on the side of a gentle declivity, and on a porous soil. It should be on the west or north-west side of a hill if possible, or at least sheltered from the north, east, and south, by high trees. In some countries, where there are natural caverns with an opening to the west, and springs of water at hand, the best and coolest dairies are thus prepared by nature. Artificial excavations in the sides of freestone rocks are sometimes formed for the purpose of keeping milk, and more frequently wine. When no such natural advantages exist, the requisite coolness in summer, and equal temperature in winter, which are essential in a good dairy, may be obtained by sinking the floor of the dairy some feet under ground, and forming an arched roof of stone or brick. In cold climates flues around the dairy are a great advantage in winter; and an ice-house in warm summers is equally useful. But these are only adapted to those dairies which are kept more as a luxury than as an object of profit. In mountainous countries, such as Switzerland, where summers are hot in the valleys, and the tops of the mountains or high valleys between them are covered with fine pastures, the whole establishment of the dairy is removed to a higher and cooler atmosphere, where the best butter and cheese are made. Coolness is also produced by the evaporation of water, an abundant supply of which is essential to every dairy. It is also a great advantage if a pure stream can be made to pass through the dairy, with a current of air to carry off any effluvia, and keep the air continually renewed.

As the milk suffers more or less from being agitated, or too much cooled, before it is set for the cream to rise, the milking-place should be as near as possible to the dairy: The milk may then be brought immediately from the cows. The dairy-house should consist of three distinct apartments below, with lofts and cheese-chambers above. The principal place is the dairy, properly so called, sunk two or three feet below the level of the ground, with a stone or brick bench or table round three sides of it to hold the milk pans. This table should be a little below the level of the outer soil. Air-holes covered with wire should be made in the walls a little above, and on opposite sides of the dairy; and they should have shutters sliding over them to open or shut according to the weather. The floor should be of stone or paving-tiles, sloping gently towards a drain to carry off the water. Great care should be taken that no water stagnates in this drain, which must be kept as clean as the floor of the dairy, and not communicate with any sink, but run out into the open air: a declivity from the dairy is essential for this purpose. If this cannot be obtained, it must run into an open tank, and the water be regularly pumped out. The windows of the dairy should be latticed. Glazed windows may be added for the winter, but they should always be open except in very hot or very cold weather. There may be shutters to close entirely, but this is not essential. If the windows are made like venetian blinds, the light will be excluded without excluding the air. The utmost purity must be maintained in the air of a dairy; nothing should enter it that can produce the slightest smell. No cheese or rennet should be kept in it; and particularly no meat, dressed or undressed. Even the dairy-maid should avoid remaining longer in it than is necessary, and should at all times be extremely clean in her person.

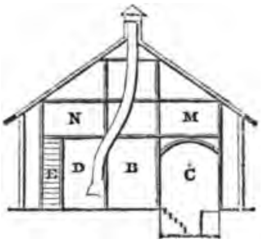
The next important place is a kind of wash-house, in which there is a chimney where a large copper kettle hangs on a crane to heat water in, or milk when cheese is made. In countries where wood is scarce, and pit-coal is the common fuel, a copper may be set in brick-work with a grate under it, as is usual in England. In this place all the utensils of the dairy are kept, and scalded with boiling water every day. It should have an outer door, which may be to the south, and benches outside on which the pails and other utensils may be set to dry and be exposed to the air. Between the two last apartments may be another communicating with both, and forming a kind of vestibule, where the churning may take place; and over them a cheese-room and lofts, or any other useful chambers. A verandah round the dairy is very convenient, or on three sides at least. It shades from the sun, and adds to the warmth in winter; and the utensils may be dried and aired under it even in rainy weather. Gentlemen's dairies are often built expensively, and highly ornamented; but they seldom unite all the conveniences essential to a good dairy, because the architects who plan them are seldom practical farmers. They are generally too far from the cow-houses. A dairy-house placed near a mansion, and at a distance from the farm-buildings, is quite out of its place. In Switzerland and in Holland the cow-house and dairy have a very neat appearance within a short distance from the principal residence. The plan in both countries is very similar; the style of the roof is the chief difference. The plan is taken from the common dairy-farms in Holland, where the farmer and his family live under the same roof with his cows. In the Netherlands, especially in North Holland and Friesland, a cow-house is as clean as any dwelling-house, and the family often assemble and take their meals in it. The following is a description of a cow-house and dairy under one roof, as in Holland: It is a building about sixty feet long by thirty wide, with a verandah running round



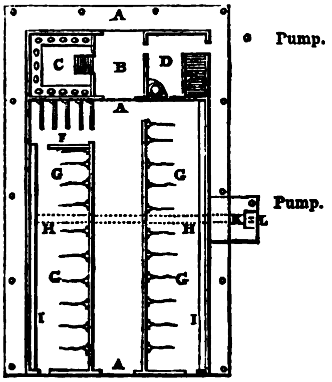
Side View.



Section of the Cow-house.



Section of the Dairy.



Ground Plan.

A, A, A, passage through the cow-house and dairy ten feet wide, paved with bricks set on edge or Dutch clinkers. The food is brought in this passage in a small cart and distributed to the cows; B, part of the above passage closed in with doors and forming a vestibule to the dairy; C, dairy-room, in which only milk, cream, and butter, are kept. It is sunk three feet under the level of the cow-house, and covered with a brick arch; it has one latticed window, and several ventilators, on a level with the place on which the milk vessels are set; D, the room where the utensils are scalded, and where cheese is made; in the corner is a fireplace, with a large kettle or a copper set; E, the stairs to go up to the cheese-room M and loft N; F, calf-pens, in which the calves are tied up to fatten, so that they cannot turn to lick themselves; a small trough with pounded chalk and salt in each pen; G, the place for the cows, without partitions; each cow is tied to two posts by two small chains and two iron rings, which run on the posts. The chains are fastened to a broad leather strap, which is buckled round the neck of each cow; H, H, two sinks, with iron gratings over them, to catch the urine from the gutters I, I, which run all the length of the cow-house on each side; K, the urine tank, vaulted over with a door, L, to clean it out, and a pump to pump up the liquid manure; O, O, in the section are places where the green food or roots are deposited for the day's consumption; P, a hay-loft.

three sides of it. The dwelling is not here attached, as it usually is in common dairies, and the building is not surrounded by a farm-yard: these are the only circumstances in which it differs from that of a common peasant. The dairy-room is sunk below the level of the soil, and is paved with brick. The sides are covered with Dutch tiles, and the arched roof with hard cement. The cow-house, like all in Holland, has a broad passage in the middle, and the cows stand with their heads towards this passage, which is paved with clinkers or bricks set on edge. Their tails are towards the walls, along which runs a broad gutter sunk six or eight inches below the level of the place on which the cows stand. This gutter slopes towards a sink covered with an iron grate, which communicates by a broad arched drain with a vaulted tank, into which all the liquid flows. The gutter is washed clean twice a day before the cows are milked. The cows stand or lie on a sloping brick floor, and have but a small quantity of litter allowed them, which is removed every day, and carried to the dung-heap or to the pig-styes to be more fully converted into dung. Whenever the litter is removed, the bricks are swept clean; and in summer they are washed with water. In Holland the cows' tails are kept up by a cord tied to the end of them, which passes over a pulley with a weight at the other end, as we see practised with horses that have been nicked: thus they cannot hit themselves, or the person who milks them. The manner in which the cows are fastened is worthy of notice: Two slight pillars of strong wood are placed perpendicularly about two feet distance from each other, so that the cow can readily pass her head between them. On each of these is an iron ring, which runs freely up and down, and has a hook in its circumference; two small chains pass from these hooks to a leather strap, which buckles round the neck of the cow. Thus the cow can rise and lie down, and move forward to take her food, which is placed in a low manger before the two pillars; but she cannot strike her neighbour with her horns. The mangers or troughs are of wood, or bricks cemented together, and are kept as clean as all the rest of the cow-house. In Switzerland the cow-houses are similar, but there is also a rack, the back of which towards the passage shuts up with a board on hinges. The Dutch mode supplies more light and air to the middle passage; and as the food is given frequently and in small quantities there is very little waste. The preceding cuts will give a tolerable idea of the whole arrangement. The food is brought in carts, which are driven at once between the cows. What is not wanted immediately is stored above, whence it is readily thrown down before the cows. Thus much trouble is saved, and one man can feed and attend to a great many cows. From November till May the cows never leave the cow-house. In summer, when they are out, if they are in adjacent pastures, they are driven home to be milked, but if the pastures are far off, which is sometimes the case, they are milked there, and the milk is brought home in boats; but this is not thought so good for the butter, which is then always churned from the whole milk, without letting the cream rise. The finest and best flavoured butter is always made from the cream as fresh as possible; and to make it rise well, the milk should be set as soon as it is milked, and agitated as little as possible. The greatest quantity is seldom obtained when the quality is the finest. When great attention is paid to the quality, the milk is skimmed about six hours after it is set; and the cream taken off is churned by itself. The next skimming makes inferior butter. These particulars are mentioned to show the necessity there is of having the dairy as near as possible to the cow-house.

The utensils of the dairy, such as pails, churns, vats, &c., are usually made of white wood, and are easily kept clean by scalding and scouring. Leaden troughs are used in large dairies; and if they are kept very clean by careful scouring, they answer the purpose better than wood. They may be so constructed that the milk may be let off gently before the cream, which is collected by itself. This saves all the trouble of skimming. Brass pans have the advantage of being readily warmed on a chafing-dish in winter. In Devonshire tin or brass pans are frequently used instead of earthenware. There is some danger in the use of brass utensils, though a very little attention will obviate it. It only requires that they should be kept bright, in which case the smallest speck of oxide or verdigris would be perceptible. Glass milk pans are coming into use, and are highly approved. In Holland the milk is invariably carried in brass vessels. Cast-iron pans have been invented, which are tinned inside. They are economical; but there is nothing better or neater than well-glazed white crockery ware, of the common oval form. Some recommend unglazed pans for summer, but they are difficult to keep sweet, as the milk insinuates itself into the pores, and is apt to become sour there.

The most common use of cows is to supply butter and cheese [Butter and Cheese], and sometimes to fatten calves [Calf] for the butcher; but the most profitable dairy is that which supplies large towns with milk. In these dairies the system is different. The cows are mostly kept in stalls, and fed with food brought to them. Some dairymen near London possess several hundred cows, and the arrangement of their establishments is worthy of notice. The cows are bought chiefly in the north, before or after they have calved. They are seldom allowed to go to the bull, but are kept as long as they can be made to give milk by good feeding. When they are dry, they are often already sufficiently fat for sale, or at all events they soon fatten, and are sold to the butcher. A succession of cows is thus kept up, new ones arriving as others are sold off. The women who purchase the milk from the dairyman and carry it about for sale, come for it to the dairy and milk the cows twice a day; and as they well know that the last drop of milk is the richest, the cows are sure to be milked quite dry, an essential thing in a dairy. An accurate account is kept of the quantity which each woman takes, which is paid for weekly. When there is more milk than there is a demand for, it is set, and the cream is sold separately, or made into butter; but this is seldom done to any extent. The cows are fed on every kind of food that can increase the milk: brewers' grains and distillers' wash are preferred, when they can be obtained. The grains are kept in large pits, pressed close and covered with earth, under which circumstances they will remain fresh a long time. Turnips and beet-root are used in large quantities; but hay is given sparingly. The cows are generally placed in pairs, with a partition between every two pair. Each cow is fastened to the corner of the stall, where she has a small trough with water before her: thus they cannot gore each other with their horns. The cows chiefly employed in the London dairies are the short-horned breed. The following passage, taken from a work published by Messrs. Blackie of Glasgow ('How to Choose a good Milk Cow'), describes the experience of a London dairyman: "A Yorkshire cow in a London dairy establishment is seldom calculated to give less than twenty quarts of milk daily for the first four months after dropping her calf, and many of their breed have been known to give from thirty to forty quarts daily for a few weeks after calving. In Mr. Biggs' dairy (Edgeware Road), twenty quarts a day is the average quantity of a great proportion of his best cows, and many of them would continue in milk all the year round; but as this would be injurious to the animal, and would diminish the yield in the succeeding year, they are intentionally run dry about six weeks before the time of calving. The whole quantity of milk produced in twelve months by one of these Yorkshire cows cannot be less than 4000 quarts, or 1000 gallons. The retail price is 1*s.* 4*d.* per gallon, and when sold wholesale to the milkman the price realised by the dairyman is not less than 1*s.* per gallon, so that from this datum it appears that a cow giving 1000 gallons per annum produces 50*l.* worth of milk during that period. Of course the feeding is very liberal, and from the high price of green food in the metropolis is necessarily very expensive. The milking and feeding in Mr. Biggs' dairy is as follows:—

4 A.M.	Milked. (A good milker can milk 16 cows in 2¼ hours.)
4 „	1 bushel basket of brewers' grains to every 2 cows.
6 „	3 bushels of swedes or mangold-wurzel to every 2 cows.
7 „	1 truss of hay to every 12 cows.
9 „	Water, which is the only time they are allowed to drink during the 24 hours in winter, and each cow drinks about 24 quarts. In summer water is given twice.
11¾ „	1 bushel of grains to 2 cows.
1 P.M.	Milked again.
2 „	3 bushels of roots to 2 cows.
3 „	1 truss of hay to 8 cows.

In summer the green food consists of clover, rye-grass, or vetches.

The cows are milked twice a day, which occupies about 2¼ hours each time. The cow-houses are cleaned out five times each day, and the gutters kept sweet by allowing water to flow through them. The cows are thoroughly combed and cleaned once a week. From the foregoing data the following calculations of the annual expense of house-feeding a London dairy cow may be deduced—

	£	s.	d
Winter Food, October 1st to May 1st.			
212 bushels of grains, at 6*d.*	5	0	6
13¼ tons of roots, at 20*s.*	13	5	0
1 ton of hay, at 90*s.*	4	10	0
Summer Food, May 1st to October 1st.			
11½ tons of grass, &c., at 20*s.*	11	10	0
153 bushels of grains, at 6*d.*	3	16	6
Total cost of food	38	2	0
Interest on capital, 16*l.* at 5 per cent.	0	16	0
Annual loss	0	16	0
Attendance	1	5	0
Total cost	£40	19	0

	£	s.	d
Produce from Cow.			
1000 gallons of milk, at 1*s.*	50	0	0
Calf	1	0	0
Manure	4	0	0
	55	0	0
Deduct expenses	40	19	0
Profit	£14	1	0

In the above calculations no charge is made for rent of premises; but though 1*l.* per cow be struck off for this, the profit is still abundant."

The great dairies about London are kept very clean; but the liquid manure, which would be so valuable for the market-gardens, is lost, and runs off by the sewers. In Belgium the urine would be contracted for at the rate of 2*l.* per cow per annum, which would produce 1200*l.* a year in a dairy of 600 cows, and would pay a good interest for the money expended in constructing large vaulted cisterns under each cow-house.

The dairy farms of England are chiefly in Gloucestershire, Devonshire, and Cheshire. They require a smaller capital than arable farms of the same extent; the chief outlay is the purchase of cows. The rent of good grass land is generally higher than if it were converted to arable land, and the risk from seasons, and the variations in the price of the produce, is much less in a dairy farm than in one where corn is chiefly cultivated. Hence the rents are better paid, and there are fewer failures among the tenants; but the profits of a dairy farm, without any arable land, are not considerable; a decent livelihood for the farmer and his family is all that can be expected. There is no chance of profit in a dairy of which the farmer or his wife are not the immediate managers. The attention required to minute particulars can only be expected in those whose profit depends upon it. The dairies of men of fortune may be arranged on the best and most convenient plan, and be indispensable articles of luxury; but the produce consumed has always cost much more than it could be purchased for. A proper attention to keeping correct accounts of every expense will convince any one of this truth. In a dairy farm the great difficulty is to feed the cows in winter. It is usually so arranged, that the cows shall be dry at the time when food is most scarce, and they are then kept on inferior hay, or straw, if it can be procured. It is a great improvement in a dairy if it has as much arable land attached to it as will employ one plough, especially if the soil be light; but the mode of cultivating this farm must vary from that of other farms, since the food raised for the cows must be a principal object. Corn is a secondary object; and the cultivation of roots and grasses must occupy a great portion of the farm. When the grasses degenerate, a crop or two of corn is taken, and the rotation is chiefly roots, corn, and grass cut for hay, until it wears out. If the roots are well manured, the land keeps in excellent heart. The old pastures are kept for summer feeding. Where there is no arable land near a dairy farm, it deserves mature consideration whether it will be advantageous or not to allow some of the pasture to be ploughed up. It is often a dangerous experiment where the soil is naturally heavy, which is the case with most dairy farms in England. Arable land laid down to grass for the purposes of the dairy seldom produces fine-flavoured butter, or good cheese; but clover-hay is excellent for young stock, or to fatten off the old cows. Lucern is reckoned to make cows give very good milk; nothing however can equal a rich old pasture, as all dairymen agree.

In hiring a dairy farm, it is an object of great importance that the buildings be situated near the centre of the land, and that they be well constructed and convenient. The nature of the feed must be ascertained by experience. It is often impossible to say by mere inspection whether a pasture will make good butter or cheese, especially the latter. But those which have no great reputation may often be highly improved by draining, and also by weeding, a thing too much neglected in pastures.

DAIS, or DEIS, a word which occurs very frequently in old English authors; as in Chaucer, 'Prologue to the Canterbury Tales,' v. 372.

> Wel semed eche of hem a fayre burgeis,
> To sitten in a gilde halle, on the *deis*.

Tyrwhitt apprehends "that it originally signified the wooden floor (Fr. *d'ais*, Lat. *de assibus*) which was laid at the upper end of the hall, as we still see it in college-halls;" and in most, if not all, of those of the city companies in London, and those belonging to the inns of court. "That part of the room being floored with planks was called the *dais*, the rest being either the bare ground, or, at best, paved with stone; and being raised above the level of the other parts, it was called *the high dais.*" He says that Menage, whose authority has led later antiquaries to interpret *deis* a canopy, has evidently confounded *deis* with *ders*. But *dais* not only signified a canopy in old French, but it is the term still employed in France for the canopy carried over the host in processions, and for that which was formerly, at least on state occasions, held above princes, ambassadors, &c. In the Dictionary of the French Academy, *haut dais* is defined to be the raised place occupied by the sovereign in public ceremonials, whether there is a dais (canopy) above him or not. It is not improbable that as originally applied to the raised platform in a hall, the term was equivalent to—place of the dais—that is, state canopy; the chief seat, which was always placed in the centre of the high board, having a canopy over it. From its central place the principal table itself seems in course of time to have been called the dais, as well as the platform upon which it stood; and people were said to sit *at the dais* instead of *at the table upon the dais*: thus, in Matthew Paris, 'Vit. Ab.,' p. 1070, "Priore prandente ad magnam mensam, quam *dais* vulgariter appellamus." The term is used in this sense by Skelton, Roy, and other writers as late as the time of the Tudors. In royal halls there were more *daises* than one. Christine of Pisa ('Hist. Cha. V.,' p. iii. c. 33) says, that at a dinner which Charles V. of France gave to the emperor Charles IV. in 1377, there were *five daises*. (Ducange, *Glossary*; Tyrwhitt's *Notes on Chaucer's Canterbury Tales*, 4to., Oxford, 1798, vol. ii., p. 403.)

DALAI LAMA. [LAMA; LAMAISM.]

DAMAGES (old French, *damage*; Latin, *damna*), in law, signifies the compensation that is given by the jury (or assessed by the court) to the plaintiff for the wrong the defendant has done to him. That wrong may consist in the non-payment of a debt or the non-performance of a bargain, in which, and similar cases, damages are said to arise *ex contractu*, being given for the breach of the contract or promise to pay the debt or perform the bargain. If the wrong be the infliction of personal injury, or the deprivation of personal liberty, or arise from slander or imputations on personal character, the damages are said to arise *ex delicto*; that is, from the delict or wrong committed by the defendant.

In actions *ex contractu*, where the parties have stipulated for a liquidated sum to be paid as damages, the jury are bound to give the full amount of that sum; but where they have stipulated merely for a penalty to be paid, the jury may give less, or if the parties do not proceed for the penalty, they may give more. If the damages given be excessive, the court will sometimes grant a new trial, but not so if they be too small; at least it is very unusual to do so, except in actions on mere money demands or on inquisitions.

DAMALURIC ACID ($C_{14}H_{12}O_4$). A volatile acid found by Staedeler, along with *damolic acid*, in the urine of the cow. It is an oily liquid, having the odour of valerian, and is heavier than water.

DAMASCENE WORK. The damask, damascene, or Damascus work, so often met with in choice specimens of metal manufacture, especially on the old Damascus sword-blades, is a method of producing a pattern or design by encrusting or inlaying one metal with another. It was introduced into Europe from the Levant, where it was much practised in the middle ages, especially at Damascus. The metals usually employed were silver or gold on copper or iron, gold on silver, or silver on gold; but any other combination would equally come within the principle of the art.

There were several different modes of damascening. If the metal to be damascened were hard, its surface was wrought into fine lines crossing each other, and the designs were afterwards traced upon it; the design marks were filled in with the metal inlay, which was fixed by a strong pressure or by hammering; and the entire work was then burnished, by which the lines uncovered by the incrustation were erased, and a fine polish given to the surface. Another method was that of hatching the incised lines only, and of fixing the incrustation as before. In a third method, when the incrusting metal was of a ductile nature, the pattern was first incised in outline, and the body of the design left on the same level as the rest of the surface; a thin strip of metal was then laid down vertically, and fixed by the insertion of its edges into the exterior incisions; the incrustation was thus in relief, and was afterwards occasionally engraved. A fourth kind of damascene work partook of the nature of *picqué*, or a design formed by small pins or studs, much in vogue in England in the 17th century.

Various European cities had artists who practised damascening; but Venice and Milan were the chief, and the art attained its greatest perfection in the 16th century.

At the Mediæval Exhibition of 1850, and the Manchester Exhibition of 1857, several beautiful specimens of damascene work were collected, including candlesticks, tankards, ink-stands, shields, etuis, swords, &c.; but the most exquisite was Cellini's far-famed shield, presented by Francis I. to Henry VIII., and now the property of her Majesty. It is made of embossed steel, damascened with gold and silver. It has represented upon it, in compartments, scenes from the history of Julius Cæsar, each consisting of numerous figures in relief of the most highly finished execution.

Damascene work is not now much practised in any part of Europe.

DAMASK, a kind of woven cloth, composed both of flax and of silk, which is believed to have been originally brought from Damascus. Linen damask is used for table-cloths and napkins. Until within the last half century, the cloths of this kind used in England were imported from Germany; but the manufacture has since that time been successfully carried on both in Scotland and in Ireland. Damask cloths are of thick texture but fine in quality, and the weaving of them puts into requisition all the skill of the weaver for the production of the elaborate patterns which they bear. Some of these patterns require upwards of twelve hundred changes of the draw-loom for their completion, the method of performing which could not be explained without going into the detail of the art of weaving; it will however be briefly treated in a later article. [WEAVING.] The weaving of silk damask was introduced into England by the Flemish weavers, who fled hither from the persecutions of the Duke of Alva in 1567. For a long time silk damask dresses were used on all occasions of ceremony by ladies of rank and by wealthy commoners; but they were never commonly worn. They were wrought with a great variety of colours, and if the patterns did not exhibit much taste they were sufficiently showy; from the quantity of silk which they contained, they were also very costly. The damask employed at the present day for curtains and the like articles of household furniture is made of a mixture of silk with flax, cotton, or wool; the warp, or long threads, being of the more costly material.

DAMMARA. A resin commonly known as *cowdie-gum*. [DAMMARIC ACID.]

DAMMARIC ACID ($C_{80}H_{59}O_{11},HO$?). A resinous acid found, along with a neutral resin, *dammarane*, in *cowdie-gum*, the product of a large tree of the coniferous species growing in New Zealand. When the cowdie-gum is submitted to distillation it yields two oils lighter than water, to which the names *dammarol* and *dammarone* have been given; they are, however, probably not definite compounds, but mere mixtures of oily hydrocarbons.

DAMMAROL. [Dammaric Acid.]

DAMMARONE. [Dammaric Acid.]

DAMOLIC ACID. [Damaluric Acid.]

DAMP, CHOKE. [Mining.]

DAMPER. There are two or three different modes in which this term is applied to small mechanical contrivances. The damper of a furnace or fire-place is a door or screen which, if drawn partially or wholly across a particular channel, lessens the passage for air, and diminishes the intensity of the heat in the furnace; this damper is therefore a check. As a check, also, does the damper of a pianoforte act; it is a small lever, which presses against a string soon after it begins to vibrate, in order that the vibrations should not continue too long, thereby injuring the completeness and effect of other sounds which are to come after; the damper checks the vibration. There are other pieces of mechanism known in the arts which check a particular action at a particular time, and which are on that account called dampers A wholly different apparatus is called a damper because it communicates dampness or moisture. When adhesive postage stamps came extensively into use, it was felt by many persons that the method of moistening the liquid gum by licking it with the tongue is both an unsightly and an unpleasant one, and is even injurious to health if often repeated. Hence the invention of damping-machines, or dampers, for moistening the gum of adhesive stamps or labels. Such machines have not come extensively into use, possibly because the requisite simplicity and cheapness have not been attained; but it is an attempt in the right direction, which may meet with ultimate success. Phelp's damper contains a cup or vessel of water, with a pipe extending from thence to a small tray on which a flat piece of sponge is placed, open at the top. Rowland's damper comprises a small vulcanised India-rubber bag or vessel, and a piece of sponge fixed in a holder inserted in the mouth of the bag. Baddeley's damper is an attempt to meet the wants of those who consider that postage stamps ought to be moistened on both sides. Schäfer's and other patented dampers have, in like manner, ingenious appliances for moistening the adhesive composition without the aid of the tongue.

DANCING. [Ballet.]

DANEGELD, sometimes called simply the GELD, was a tax originally imposed, in order, says Thierry ('History of the Norman Conquest'), to maintain a coast-guard against the incursions of the Scandinavian pirates. He adds, that it was this identical fund that was offered to the invaders by way of tribute. The ordinary revenues of the crown were quite inadequate to the expense of either maintaining a force to fight, or to produce the means of bribing their ferocious enemies; and therefore it was found necessary, with the consent of the Wittenagemot, to impose a tax, first of one Saxon shilling, and afterwards of two or more shillings, on every hide of land in the kingdom. In the laws of Edward the Confessor, who abolished the tax, it is spoken of as follows:—De Danegeldo—Danegeldo redditio propter pyratas primitus statuta est. Patriam enim infestantes vastationi ejus pro posse quo insistebant. Ad eorum quidem insolentiam reprimendam statutum est, Danegeldum annuatim reddit; scilicet, 12 denarios ex unaquaque hida totius patriæ, ad conducendos eos qui piratarum irruptioni resistendo obviarent. (Wilkins's 'Leges Anglo-Saxonicæ.') It is known that "in 991 they were bribed and bought off with ten thousand pounds of silver; in 994 with sixteen thousand; in 1001 with twenty-four thousand; in 1007 with thirty-six thousand; and in 1012 with forty-eight thousand. A pound of silver was worth about three pounds of modern money, and would have purchased eight oxen, or fifty sheep." ('Popular Hist. of Eng.,' by C. Knight.) According to the 'Saxon Chronicle' (edit. Gibs., p. 116), this tax was first imposed in 991; it was soon after raised to two and at last to seven shillings on every hide of land, and continued to be levied long after the original occasion of imposing it had ceased.

Whilst the invasions of the Danes were almost annual, our kings derived little profit from this tax, which was all expended in bribing or fighting these invaders; but after the accession of the Danish princes to the throne of England, it became one of the chief branches of the royal revenue. This tax was raised so high, and collected with so much severity by King Canute in 1018, that it amounted to the prodigious sum of 71,000*l.*, besides 11,000*l.* paid by the city of London. ('Chron. Sax.,' ut supr., p. 151.)

Edward the Confessor, who succeeded Hardicnut in 1042, and put a stop to all future payments from the English to the Danes, as well tributary as stipendiary, continued nevertheless to collect danegeld from the subject until the year 1051, when, as Ingulphus and other authors say, he absolutely repealed it. It was revived at an early period of William the Conqueror's reign, and, according to Webb, in his 'Short Account of Danegeld' (4to, Lond. 1756, p. 2), continued to be collected as low as 21 Hen. II., if not later. In the Domesday Survey, danegeld occurs but once by its own name (tom. i., fol. 336 b.), under Stamford, in Lincolnshire. It is mentioned as one of the *Jura regalia* in the Laws of Henry I., chap. 10. Stephen, at his coronation, took an oath that he would remit this tax. (Compare Spelman's and Du Cange's 'Glossaries,' v. 'Danigeldum.')

DANES is the general appellation given to the Scandinavian tribes which in the 9th and 10th centuries became so formidable by their predatory expeditions, and invaded and occupied a great part of Britain and France. The early history of the Scandinavian nations is involved in great obscurity, though Danish and Swedish chroniclers gravely deduce their genealogy from Japhet and his son Gog, and relate their early migration from Asia. But coming to more historical times, there is a poem on the exploits of the Danes in the 3rd and 4th centuries, which refers to their wars among themselves, and in which the Danes, properly so called, or Western Danes, appear as the inhabitants of Jutia, who are also called Scyldingi; while the Sveones (perhaps the same as the Suiones), mentioned by Tacitus ('German') as living near the shores of the Baltic, are called also Eastern Danes, or inhabitants of part of the country now called Sweden. Next to these are mentioned the Geata, or Goths; and in the islands of the Baltic, the Sæ Geata, or Sea Goths, called also Scylfingi. We find also mention of the Northern Danes, probably the Norwegians. ('De Danorum Rebus gestis Seculis III. et IV. Poema Danicum dialecto Anglo-Saxonica ex bibliotheca Cottoniana Musæi Britannici,' edited by G. J. Thorkelin, 4to, 1815.) The common language of all these people was the Norse or Dönsk Tunga, which is still spoken in Iceland. (P. Vidalini, 'De Appellatione Linguæ Septentrionalis, 1775.)

Scandinavian migrations had taken place to North Britain in very remote times; and it appears probable that some of the tribes which inhabited Caledonia in the Roman period had come originally from that quarter. The Jutes and Angli, who, with the Saxons, conquered Britain, came from Jutia, the country of the Western Danes. But after the Saxon conquest, the connection between the migrated tribes and the Danes who had remained in Scandinavia became obliterated, until the end of the 8th century, when the Danes began to make war upon their old kinsmen with all the fierceness of inveterate enemies. Their predatory descents on the coast of Britain became formidable during the reign of Egbert; and under his successors the Danes obtained possession of great part of the island, until Alfred the Great defeated them, and obliged the Danish chieftains to submit. [Alfred, in Biog. Div.] The eastern part of England retained long after the name of Danelagh, or Danish Law, and the population was in great measure of Danish stock, especially to the north of the Humber. After the death of Alfred fresh incursions took place, until, at the beginning of the 11th century, Canute, or Knut, having established himself as sovereign of all the Scandinavian nations, added Britain also by conquest to his sceptre. [Canute, in Biog. Div.] After Canute's death his successors Harold and Hardicnut held the sway of Britain for a few years longer, after which the line of the Saxon kings was restored in the person of Edward the Confessor. The Norman conquest, which followed close upon the death of the latter, put an end to the Danish invasions on the coasts of Britain. But the Normans themselves were originally of Danish stock in the general sense of the name, having settled in North France under Rollo the Ganger in Alfred's time; and those Norman pilgrims and knights who conquered the kingdoms of Sicily and Apulia in the 11th century were likewise their progeny.

DAPHNINE. Vauquelin first pointed out, in the 'Annales de Chimie,' t. lxxiv., the existence of a peculiar acrid principle in the mezereon (*Daphne Mezereon*). Its properties have been since more particularly examined by Gmelin and Bär. It is prepared by precipitating a decoction of mezereon bark by subacetate of lead, and decomposing the washed precipitate by sulphuretted hydrogen; the solution is then filtered, evaporated, and the residue digested in cold anhydrous alcohol, from which daphnine crystallises.

When it has been purified by washing with cold alcohol, solution in water, and recrystallisation, it forms colourless bitter crystals, which possess neither alkaline nor acid reaction: in cold water they are sparingly soluble, but more so in hot, and also in alcohol and ether. Nitric acid converts it into oxalic acid. It does not appear to have been analysed.

DARIC (*Δαρεικός*, *Daricus*), a Persian coin of pure gold, stamped on one side with the figure of an archer crowned, and kneeling upon one knee, upon the other with a sort of quadrata incusa, or deep cleft. Harpocration (*in voc. Δαρεικός*) ascribes its origin and name to a Darius of a remote period; but Wesseling ('Observat. Variæ,' 8vo, Traj. ad Rhen., p. 241) and other later writers, upon the authority of Herodotus, give it to Darius Hystaspis, the father of Xerxes, who began his reign B.C. 521. The daric was equivalent in value to the Attic Chrysus (*χρυσοῦς*), and was worth twenty drachmæ of silver: five darics were consequently equal to an Attic mna of silver (Harpocration). Xenophon, in his 'Cyropædia' (vii.), informs us that the daric was a month's pay for a common soldier. Prideaux ('Connect. of Old and New Test.,' 8vo, Lond. 1725, i. 183) observes, that in those parts of Scripture which were written after the Babylonish captivity (he refers to Chron. xxix. 7, and Ezra viii. 27), these pieces are mentioned by the name of *Adarkonim*; and in the Talmudists (see Buxtorf's 'Lexicon Rabbinicum,' p. 577) by the name of Darkemon, both from the Greek *Δαρεικός*. It has been suggested, however, that the name is derived from the Persian *daar*, a king, and in that case the daric may have had an origin even earlier than Darius the Mede, and might have been known to the Jews prior to the Captivity. Darics were the gold coins best known in Athens; and when the supply became deficient, imitations of them were made, and hence the existing darics are mostly of Greek manufacture. It would seem extraordinary, when we consider the great number which are recorded to have been employed in presents and bribes alone, exclusive of the purposes of traffic, that so few should have reached modern times, if we did not know that upon the conquest of Persia they were melted down, and re-coined with the type of Alexander. Very few Persian darics are now to be seen in cabinets. There is one in Lord Pembroke's, which weighs 129 grains; and there are three in the cabinets of the British Museum, weighing about 128½ grains each. Mr. Young, the eminent dealer in coins, also possessed two, one weighing about 121¼ grains, the other 128¼. The witticism of Agesilaus (Plutarch, 'Apophthegm Lacon.' xl.) is well known, who, being forced to retire from an invasion of the Persian provinces by the bribery used by the great king, said that 30,000 *archers* had defeated him.

The silver coins which go by the name of darics are in truth miscalled. They had no such designation in ancient times. The earliest of them, if we may rely upon Herodotus in a passage already referred to (iv. 166), were struck by Aryandes, the Persian governor of Egypt, in imitation of the darics. "This Aryandes was governor of Egypt, and had been appointed by Cambyses. Some time after, presuming to put himself on an equal footing with Darius, he lost his life in consequence. Hearing by report, and seeing himself, that Darius was desirous to leave some memorial behind him, such as no other king had done, Aryandes followed his example, and met with his reward. Darius took the best gold, and purifying it to the highest degree, struck a coin. Aryandes, being governor of Egypt, did the same in silver; and the silver of Aryandes is now the purest. Darius being informed of what he was doing, put him to death, under the pretence that he was meditating a revolt." The coining of these darics or Aryandics in silver, however, must have been continued after the time of Aryandes. No fewer than eight specimens of this description are in the cabinets of the British Museum. One, formerly Mr. R. P. Knight's, bears the name of Pythagoras, as Mr. Knight conjectured, a king or governor of Cyprus. Others, which have the figure of the archer crowned on one side, have a mounted horseman on the other. They are generally considered as ancient Persian coins, and are commonly, though without any assignable reason, except as bearing the figure of an archer, called darics.

	Grains.
Daric of gold in the British Museum . . .	$128\frac{4}{10}$
Do.	$128\frac{4}{10}$
Do.	$128\frac{4}{10}$
Daric of silver	$235\frac{8}{10}$
Do.	$228\frac{9}{10}$
Do. smaller of silver	84

Gold Daric, magnified one-third.

Silver Daric. British Museum. Actual Size. Weight, $235\frac{8}{10}$ grains.

DATA, DATUM. A datum is any quantity, condition, or other mathematical premiss which is given in a particular problem. Thus in the question "to draw a circle which shall have its centre in a given line, and shall touch two other straight lines," the data are as follows: 1, That the figure described is to be a circle; 2, a certain straight line; 3, that the centre of the circle is to be on that straight line; 4, two other straight lines; 5, that the circle is to touch those straight lines. Data may be divided into two classes, the latter class being the restrictions which it is necessary to place upon the class already described in order that the problem may be possible. Thus the preceding problem becomes absurd when the three straight lines are parallel, unless the line on which the centre of the circle is to lie be midway between the two others. Either then the problem must be proposed with the limitation "if it be possible," or an express datum of exclusion must be introduced, namely, that the three straight lines must not be parallel, unless, &c.

In the mere etymology of the word datum all legitimate consequences are data when the premises are data. Thus, given two circles which touch, there are also given two circles which have a common point in the line joining their centres. The book of Euclid known by the name of Data (δεδομένα) is the deduction of magnitudes from other magnitudes, not as to what they are, but as to whether they are determined or not. Thus, one of the propositions is, "If a given magnitude be cut in a given ratio, the segments are given." The preface of Marinus to this book contains a dissertation on the meaning of the term.

DATISCIN. This name appears to have been given to two distinct substances, 1st, to a variety of starch [INULIN]; and, 2nd, to a yellow colouring matter contained in the leaves of the *datisca*.

DATURA STRAMONIUM. [STRAMONIUM.]

DATURINE. [ATROPINE.]

DAUCUS CARO'TA, *Medical Properties of.* The carrot has been sufficiently described. [CARROT; DAUCUS, NAT. HIST. DIV.] For medical purposes the root of the cultivated plant, and the fruit (called improperly *seeds*) of the wild plant, are used. The former rasped down into a fine pulp is sometimes applied raw to chapped nipples, and even cancerous ulcers; but more commonly it is boiled, and beaten into a uniform mass, and applied as a poultice to fetid, sloughing, and other ill-conditioned sores, which it cleanses, and otherwise improves. Upon what its power depends is not well ascertained: the juice of the root, analysed by Wackenroder, gave the following constituents:—

Uncrystallisable sugar, with starch and malic acid .	93·71
Albumen	4·35
Fixed oil (along with some volatile oil) . . .	1·00
Carotin	0·34
Ashes containing alumina, lime and iron . .	0·60
	100·00

A little pectic acid is found.

Carotin is a ruby-coloured substance occurring in four-sided plates. It is tasteless, odourless, insoluble in water, soluble in alcohol, and in ether, more so if fat be present, also in fatty or fixed oils, which it colours yellow.

The volatile oil is colourless, of a peculiar penetrating odour, and disagreeable taste. Thirty-four pounds of the fresh root yield only half a drachm of oil. Probably the oil of the seeds is similar. (Pereira.) The fruits of the wild carrot are about one line and a half long, oval, flat, and clothed along the ridges with hairs. The odour is peculiar, aromatic; the taste aromatic and bitter. Their primary action is warming and carminative; and in their secondary effects, they are occasionally diuretic. They are seldom used. The root of the wild carrot is said to produce injurious effects, and should be avoided.

The cultivated carrot, particularly the yellow kind, contains in the root a large quantity of starch. This is greatest when it is raised on unmanured ground, exactly as wheat when raised on undunged ground has more starch and less gluten than when manured. The quantity in the carrot seems greatest about the end of September. One hundred pounds (troy weight) of the fresh root then yield four and a half ounces of starch. It has been proposed to separate this starch in the same manner as starch from potatoes, to employ it medicinally as a very soothing and demulcent article of food for persons with pulmonary irritation and the cough which remains after the influenza. It is most likely a very digestible form of starch, but not more so than arrow-root. It may be raised at a cheap rate, however, as any light soil will answer, and as no manure is needed it cannot be expensive. The refuse after the starch is extracted is good for cattle, and should not be wasted. The white or Flemish carrot is a valuable food for cattle.

(Rham's *Flemish Farming.*)

DAUPHI'N, the title given to the eldest son of the king of France under the Valois and Bourbon dynasties. The origin of the word has been a matter of some dispute. The Counts of Albon and Grenoble are mentioned first in the 9th century as feudatories of the kingdom of Arles; they afterwards assumed the title of Counts of Vienne, and became independent, like other great feudatories. Guy VIII., Count of Vienne, is said to have been surnamed Le Dauphin, because he wore a dolphin as an emblem on his helmet or shield. The surname remained to his descendants, who were styled Dauphins, and the country which they governed was called Dauphiné. It included the present departments of Isère, Drôme, Hautes Alpes, and Basses Alpes. Humbert II., de la Tour du Pin, the last of the Dauphin dynasty, having lost his only son, gave up his sovereignty by treaty to King Philippe de Valois in 1349, after which he retired to a Dominican convent. (Moreri, and the French historians.) From that time the eldest son of the king of France has been styled Dauphin, in the same manner as the eldest son of the king of England is styled Prince of Wales. Since the dethronement of the elder branch of the

Bourbons in 1830, the title of Dauphin has been disused. The last who bore it was the Duke of Angoulême, son of Charles X.

DAVID'S DAY, ST., March 1. St. David, archbishop of Menevia, now called from him St. David's, in Pembrokeshire, lived in the 5th and 6th centuries of the Christian era; Pits ('De Illustribus Angliæ Scriptoribus') tells us that he died at the age of 146 years. He is said, in the days of the memorable Arthur, to have gained a victory over the Saxons, his soldiers during the conflict, for distinction and as a military colour, wearing *leeks* in their caps. In memory of this fight the Welsh still wear the leek on St. David's Day; and it is to this that Shakspere alludes in 'Henry V.,' act v. sc. 1, when he makes Gower upbraid Pistol for mocking "at an ancient tradition, begun upon an honourable respect, and worn as a memorable trophy of predeceased valour.' (See Brand's 'Popular Antiq.,' edited by Sir H. Ellis, 4to, vol. i.; Brady's 'Clavis Calendaria, 8vo, Lond. 1812, vol. i. p. 228, &c.)

DAY. Any astronomical period which depends directly upon the earth's rotation; or the interval between two transits over the meridian of any point in the heavens, real or imaginary. But the only *days* distinguished by that name in astronomy are the *sidereal day*, the *real solar day*, and the *mean solar day*.

The *sidereal day* is the interval between two transits of the same fixed star; that is, the absolute time of revolution of the earth. It is divided into 24 sidereal hours, &c. It begins when the equinox is on the meridian of the place.

The *real solar day* is the interval between two noons or transits of the sun over the meridian. Owing to the unequal motion of the sun, as well as the obliquity of the ecliptic, it is not of the same length at all periods of the year. The *mean solar day* is the average of all the real solar days; it is derived by supposing a fictitious sun to move round the equator, and uniformly in the same time as the real sun moves from an equinox to the same again. The method of adapting the motion of this fictitious body to that of the real sun will be explained in TIME, EQUATION OF.

The civil day, in England at least, is the mean solar day, and begins at midnight; that is, when the fictitious sun is on the invisible part of the meridian. But the astronomical day always begins at the noon of the civil day, and the hours are reckoned forward up to 24. Thus eleven o'clock in the morning on the twelfth of January (civil reckoning) is 23 hours of the astronomical *eleventh* of January. After noon, and up to midnight, the astronomical and civil reckoning coincide.

The mean solar and sidereal days are thus related: the mean solar day is 24h. 3m. 56·55s., of sidereal time; and the sidereal day is 23h. 56m. 4·09s., of a mean solar day.

The ancients almost universally began their day at sunrise, with the exception of the Arabians, who began at noon, and the Egyptians at midnight. Among the moderns, most of the Eastern nations begin at sunrise, with the exception of the Arabians, who still begin at noon, and the Chinese, who rockon from midnight. The Austrians, Turks, and Italians reckon from sunrise, and other European nations from midnight.

DAYS OF GRACE. [BILL OF EXCHANGE.]

DEACON, an ecclesiastical term of Greek origin, from Διάκονος (Diáconus, literally, *a servant*), introduced into the Saxon vocabulary, and continued in use to the present time.

It designates one of the *orders* in the Christian priesthood, the lowest of the three— bishops, priests, and deacons.

The first institution of the order is particularly set forth in the sixth chapter of the Book of Acts. The administration of the charities in the Church of Jerusalem was complained of as partial by the Grecian converts. The apostles, in whom the administration had been vested, thought it expedient to divest themselves of this duty, and to devolve it on other persons, that they might devote themselves to prayer and to the ministry of the word. Seven persons were selected for the office, and by prayer and the imposition of hands ordained deacons.

It appears by the first Epistle of St. Paul to Timothy, that there were deacons in other Christian churches, and probably in all where such an officer was needed. He gives instructions (chap. iii. 8-13) respecting the character which became persons who should be admitted into the office. See also Phil. i. 1. There were also deaconesses in the primitive church, one of whom, Phœbe, is mentioned Rom. xvi. 1. This female officer may be traced to the 11th or 12th century.

The peculiar office of both deacons and deaconesses was to attend to works of mercy, to be the administrators of the alms of the more opulent members of the church.

In the English church the name continues, and the peculiar form of ordination, but the peculiar duties of the office seem to be lost sight of. In fact the Poor Laws, by creating certain civil officers whose duty it is to attend to the necessitous, have rendered the services of the deacon in this his characteristic capacity less necessary.

In some dissenting communities there are deacons who still discharge the duties for which the office was instituted, collecting the alms of the people at the sacrament, and distributing them among the poor. But they are always laymen, or persons who have not gone through the forms, generally few and slight, of ordination, as practised among the dissenters.

There is a form for the ordination of deacons in the English church: some clergymen never take priest's orders. It appears by the Rubric that a person in deacon's orders is empowered to read publicly the Scriptures and homilies, to catechise, to preach when licensed to do so by the bishop, and to assist a priest in divine service, and especially in the Communion. When contemplated in the light in which this form places him, he appears as an assistant to a priest, for he is to seek out the sick and poor and report them to the priest, and in the absence of the priest to baptize. This latter permission has led to the introduction of the performance of other ecclesiastical duties, namely, the celebration of matrimony, and the burial of the dead. In fact, the deacon performs all the ordinary offices of the Christian priesthood, except consecrating the elements at the administration of the Lord's Supper, and pronouncing the absolution.

A person may be ordained deacon at twenty-three. He may then become a chaplain in a private family; he may be curate to a beneficed clergyman, or lecturer in a parish-church, but he cannot hold any benefice, or take any ecclesiastical promotion. For this it is requisite that he take priest's orders.

DEAD OIL. [COAL TAR.]

DEAF AND DUMB, CENSUS OF THE. Till the census of 1851 was taken, the public was without the usual official means of knowing the proportion of the deaf and dumb to the population of the kingdom. No previous account of the people had recognised either the deaf and dumb, or the blind. A statement was made about twenty-five years before, in the annual report of one of the provincial institutions for the deaf and dumb, that the number of deaf mutes in England and Wales alone was not less than 8000, and it was generally received with discredit. In the 'Journal of Education,' No. XIV. (1834), it was stated that actual returns had been procured from various parts of the kingdom, from which it was inferred that the proportion of deaf and dumb persons in South Britain was 1 in 1700; and this data was generally established in the minds of those most interested in the management of the various institutions for this class. The correctness of these estimates was sufficiently confirmed when the registrar-general's report was published. The total number of the deaf and dumb, returned in the various enumerations for the United Kingdom, being—

	No. of Deaf and Dumb.	Population.	Proportion.
England	9,543	16,738,695	1 : 1754
Wales	771	1,188,914	1 : 1542
Scotland	2,155	2,888,742	1 : 1340
Ireland	4,747	6,552,324	1 : 1380
Islands in British Seas	84	143,126	1 : 1704
Total	17,300	27,511,801	1 : 1590

The above proportions vary in different parts of the kingdom. The county enumerations present some notable facts to which attention will be directed, inasmuch as they not only confirm certain opinions and facts previously known, and thus corroborate the general accuracy of the census returns, but they also point to other facts both new and valuable. The counties of England, Wales, and Scotland, are grouped in twelve geographical divisions:—

I. London, comprises parts of Middlesex, Surrey, and Kent: in the repetition of these counties below, their metropolitan portions are excluded. In London the proportion of deaf and dumb to the population is 1 in 1783.

II. SOUTH-EASTERN DIV.	1 in 1948
1. Surrey (ex-metro.)	,, 1947
2. Kent (ex-metro.)	,, 2343
3. Sussex.	,, 1657
4. Hampshire	,, 2000
5. Berkshire	,, 1674
III. SOUTH MIDLAND DIV.	1 in 1902
6. Middlesex (ex-metro.)	,, 2215
7. Hertfordshire	,, 1871
8. Buckinghamshire	,, 1614
9. Oxfordshire	,, 2027
10. Northamptonshire	,, 1828
11. Huntingdonshire	,, 3016
12. Bedfordshire	,, 1754
13. Cambridgeshire	,, 1845
IV. EASTERN DIV.	1 in 1665
14. Essex	,, 1490
15. Suffolk	,, 1724
16. Norfolk	,, 1785
V. SOUTH-WESTERN DIV.	1 in 1393
17. Wiltshire	,, 1426
18. Dorsetshire	,, 1406
19. Devonshire	,, 1410
20. Cornwall	,, 1278
21. Somersetshire	,, 1448
VI. WEST MIDLAND DIV.	1 in 1610
22. Gloucestershire	,, 1565
23. Herefordshire	,, 1054
24. Shropshire	,, 1493
25. Staffordshire	,, 1860
26. Worcestershire	,, 1160
27. Warwickshire	,, 2026

VII. NORTH MIDLAND DIV.	1 in 1750
28. Leicestershire	,, 1958
29. Rutlandshire	,, 1714
30. Lincolnshire	,, 1870
31. Nottinghamshire	,, 2088
32. Derbyshire	,, 1272
VIII. NORTH-WESTERN DIV.	1 in 2014
33. Cheshire	,, 1874
34. Lancashire	,, 2045
IX. YORKSHIRE	1 in 1717
35. West Riding	,, 1640
36. E. Riding (with York)	,, 2231
37. North Riding	,, 1754
X. NORTHERN DIV.	1 in 2058
38. Durham	,, 2480
39. Northumberland	,, 1818
40. Cumberland	,, 1917
41. Westmoreland	,, 1622
XI. WALES & MONMOUTHSH.	1 in 1542
42. Monmouthshire	,, 2300
43. South Wales	,, 1423
44. North Wales	,, 1514
XII. SCOTLAND:	
Southern Counties	1 in 1480
Northern Counties	,, 1156
IRELAND:	
Leinster	1 in 1474
Connaught	,, 1499
Ulster	,, 1318
Munster	,, 1317

With this table we may compare the one for France in Departments to the 1st of January, 1853, taken from 'Le Bienfaiteur des Sourds-muets et des Aveugles,' by the Abbé Daras; which is followed by a few extracts from the Abbé's observations on the distribution of the deaf and dumb in France; we shall then review the table of the English counties.

TABLE OF THE PROPORTION OF THE DEAF AND DUMB IN FRANCE.

No.	Departments.	Proportion.	No.	Departments.	Proportion.
1.	Corsica	1 in 686	44.	Nord	1 in 1245
2.	Haut-Rhin	„ 691	45.	Finisterre	„ 1254
3.	Basses-Pyrénées	„ 711	46.	Orne	„ 1256
4.	Bas-Rhin	„ 748	47.	Indre-et-Loire	„ 1257
5.	Moselle	„ 757	48.	Yonne	„ 1342
6.	Hautes-Alpes	„ 776	49.	Cher	„ 1343
7.	Isère	„ 802	50.	Vienne	„ 1356
8.	Lozère	„ 836	51.	Morbihan	„ 1362
9.	Meuse	„ 855	52.	Loiret	„ 1364
10.	Puy-de-Dôme	„ 880	53.	Haute-Vienne	„ 1376
11.	Hautes-Pyrénées	„ 886	54.	Lot	„ 1377
12.	Ariège	„ 897	55.	Ardennes	„ 1380
13.	Gard	„ 910	56.	Var	„ 1387
14.	Cantal	„ 918	57.	Rhône	„ 1388
15.	Basses-Alpes	„ 927	58.	Loir-et-Cher	„ 1408
16.	Pyrénées-orientales	„ 928	59.	Calvados	„ 1415
17.	Meurthe	„ 934	60.	Lot-et-Garonne	„ 1416
18.	Landes	„ 947	61.	Dordogne	„ 1445
19.	Haute-Loire	„ 948	62.	Indre	„ 1446
20.	Jura	„ 976	63.	Manche	„ 1472
21.	Somme	„ 1001	64.	Hérault	„ 1474
22.	Charente	„ 1015	65.	Bouches-du-Rhône	„ 1484
23.	Creuse	„ 1059	66.	Gironde	„ 1491
24.	Doubs	„ 1059	67.	Charente-Inférieure	„ 1511
25.	Drôme	„ 1064	68.	Gers	„ 1522
26.	Haute-Garonne	„ 1092	69.	Tarn-et-Garonne	„ 1532
27.	Allier	„ 1115	70.	Côte d'Or	„ 1533
28.	Eure	„ 1120	71.	Ille-et-Vilaine	„ 1553
29.	Vaucluse	„ 1140	72.	Aude	„ 1557
30.	Oise	„ 1140	73.	Marne	„ 1561
31.	Ain	„ 1143	74.	Sarthe	„ 1566
32.	Côtes-du-Nord	„ 1148	75.	Mayenne	„ 1573
33.	Haute-Marne	„ 1151	76.	Aube	„ 1578
34.	Seine-et-Marne	„ 1163	77.	Seine-et-Oise	„ 1585
35.	Pas-de-Calais	„ 1190	78.	Vendée	„ 1592
36.	Saône-et-Loire	„ 1192	79.	Haute-Saône	„ 1623
37.	Ardèche	„ 1200	80.	Eure-et-Loire	„ 1647
38.	Deux-Sèvres	„ 1225	81.	Nièvre	„ 1686
39.	Aisne	„ 1231	82.	Loire-Inférieure	„ 1727
40.	Loire	„ 1234	83.	Maine-et-Loire	„ 1777
41.	Aveyron	„ 1235	84.	Tarn	„ 2123
42.	Corrèze	„ 1238	85.	Seine	„ 2481
43.	Vosges	„ 1242	86.	Seine-Inférieure	„ 2515

The Abbé Daras very properly says, "If a province of France produces on an average one deaf and dumb to 700 individuals; if other districts present only a single case among 2000; and if, again, between these extremes, numerous departments have one in 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, &c., according to their situation, to the south or north of the empire, in a mountainous or flat country, in healthy or unhealthy places, in manufacturing or agricultural districts, &c.; it is evident that this statistical result reveals to families, and even furnishes to the administration, knowledge which may be applied to lessen or extenuate this fearful evil of humanity."

The physical and social aspects of France are thus connected by the Abbé with the facts revealed in the census. "The irregular tablelands which border the frontiers of France on the north, south, and east, and the uncultivated moors which extend on the west to the borders of the ocean, produce the largest number of deaf-mutes. There, on an average, one is found to every 800 inhabitants. The beautiful plains which occupy the centre of the country, on the contrary, contain only one in 1600 inhabitants. The high summits of the Alps, the chain of the Pyrénées, the precipices of the Jura, the flanks of Cevennes, the volcanic soil of Puy-de-Dôme, the rocky Corsica, the rugged regions of Lozère and Cantal, comprehend the provinces most afflicted with deaf-dumbness. There are twenty departments which contain one deaf-mute in 600, in 700, in 800, or in 900 inhabitants, whilst those fertile districts in the interior, which extend themselves by an inclined plain from the western slope of the Alps, of Jura, and of the Vosges towards the Atlantic, contain a much lower proportion; about forty departments exhibit only one deaf-mute in 1300, 1400, 1500, and so on even to 2000 inhabitants.

"With the map of France before us, if we trace to the east the continuous barrier which stretches from the woody Ardennes and the Argonne to the Vosges, and which goes on from the Vosges to the Jura, to the Alps, to the Cevennes, to the Pyrénées, along the frontiers of Baden, Switzerland, Sardinia, the borders of the Mediterranean and Spain, there will be found in Lorraine, Alsace, Franche-Comté, Bresse, Bugey, Dauphiné, Forez, Limagne, Velais, Gévaudan, Vivarais, Rouergue, Rousillon, Bigorre, Béarn, Gascony, rural populations which have lived for ages in the shades of their forests, on the craggy sides of their mountains, or near to the uncultivated borders of their marshy lakes. One can easily imagine that congenital or acquired deafness, and consequent dumbness is multiplied in such localities in a much greater proportion than among those happy populations spread over the rich and salubrious countries of Berri, Touraine, and the Isle of France.

"Having studied this general rule of topographic hygiène in all its applications, we are surprised to find it confirmed where we might expect to meet with an exception. Thus, for example, Provence and Languedoc which separate the Alps from the Cevennes, would appear naturally to produce as many deaf-mutes as the mountains in their vicinity; but no, Provence and Languedoc, being countries with a flat surface and highly cultivated, obey the general rule, and contain fewer unfortunates. It is remarkable that the departments of the Var, Hérault, the Mouths of the Rhône, Aube, Lower Charente, and those watered by the Garonne, only count one deaf-mute on 1500 inhabitants; this ratio applies also to the central level of the country, to the maritime coasts of Brittany, to the valleys of Normandy, to the chalky plains of Champagne, to the hills of Burgundy, and to the river populations of the large streams which flow in the interior. It is not so in the departments covered with thick and old forests, surrounded with mountains, torn with volcanoes, inundated by the waters of lakes, infected by exhalations from marshes. In the first rank of these are Corsica and the Haut-Rhin, which present one deaf and dumb in 600 inhabitants; then come three departments situated on the Alps, the Vosges, and the Pyrenees, which contain one in 700 inhabitants; then come Isère, at the foot of Jura, between the Cevennes and the Alps, Lozère and Puy-de-Dôme, extending along the ridge of the mountains of Auvergne, and lastly Ariège, an escarpment of the Central Pyrénées; in these departments we find one deaf-mute in 800 inhabitants.

"The departments which are about to follow are under similar conditions of climate, temperature, and topographic hygiène; they are Gard, at the foot of the Cevennes, which has one deaf-mute in 910 inhabitants; Cantal, covered with a population thrown on the granite soil of High Auvergne, counting one deaf-mute in 917 inhabitants; the Lower Alps, shaded by Mount Viso and the neck of Argentière, and constantly exposed to unhealthy cold and damp winds, producing one deaf-mute in 927 inhabitants; the Eastern Pyrénées, overlooked by the high summits of the neck of Perche, the neck of Arras, and the neck of Pertuis, showing one deaf and dumb in 928 inhabitants; and, lastly, the Landes and the Jura, evidently subjected by the nature of the soil and the topographical character to the same morbid vicissitudes, and giving one deaf and dumb respectively to 946 and 976 inhabitants."

The Abbé calls the attention of all who are interested by duty or by their avocations to the observation of these phenomena; he considers that natural consequences may be deduced from the facts he has accumulated, and the observations which he has made, which may tend to shed light on one of the most insolvable and mysterious problems of general hygiène. The average number of deaf-mutes in France is high compared with other countries, and with the proportion assigned to Europe, namely, in France 1 in 1212; in Europe 1 in 1585. In France, as elsewhere, there are social causes at work, producing both congenital and acquired deafness, such as the influence of hereditary predispositions, the intermarriage of blood-relations, the secluded habits of certain communities, and other conditions of life, the moral and physical temperaments, and ignorance of the nature and consequence of certain diseases; and to these, as well as to climate, situation, soil, atmosphere, and other topographical influences, a large proportion of the deaf-dumbness so prevalent must be attributed; at the same time there are anomalies in France as elsewhere, which for the present defy all efforts towards their solution.

It is not possible to give such apparently plausible reasons for the greater or less prevalence of deafness in the different counties of England, as the extracts above give with reference to the various departments of France, yet there are some notabilities, as well as some anomalies, which it seems desirable to place on record. Taking the two counties in which deafness appears most to prevail, Herefordshire with 1 in 1054, Worcestershire with 1 in 1160; it appears at first sight that these two counties are among the healthiest in England, both bring to the mind hop-yards, orchards, and fertile lands, watered with fine rivers. Herefordshire, though not mountainous as a whole, is almost hemmed in by high lands; on the north by those of Shropshire, on the west by the Black Mountains and those of Radnorshire, on the east by the Malvern Hills and the Forest of Dean; Worcestershire is almost similarly enclosed, having the Clent and the Lickey Hills on the east, and the Malvern and Abberley Hills on the west; some of these hills are however considered the most healthy districts in England. It is not surprising to find Derbyshire and Cornwall respectively with 1 in 1272 and 1 in 1278 inhabitants deaf and dumb. Both experience and tradition point to mineral districts and exposed maritime coasts as unwholesome to the constant dwellers there. Derbyshire has long been known as a county in which goître prevails, and glandular swellings, arising from struma, are often the cause of deafness. Cornwall, though mild in climate, is exposed to the heavy clouds from the Atlantic, surcharged with moisture, which being condensed by the high lands in the centre of the county, pour forth torrents of rain. The prevalent moisture in this case may be favourable to conditions which produce congenital or acquired deafness. The next group of counties, with their proportions of deafness varying from 1 in 1406 of the inhabitants to 1 in 1493, are Dorsetshire, Devonshire, South Wales, Wiltshire, Somersetshire, Essex, and Shropshire; all these are maritime districts except the last; the mere vicinity of the sea in these fine climates of the south of England cannot surely be favourable to the production of deafness, and we must look for some other cause for the mysterious visitation. Shall we look for it in social causes? There is much struma on the coast, but it often arises from the poverty of the population—irregular work and wages—unequal and often poor feeding—exposure to weather—and bad dwellings without due means of ventilation; these observations apply to most of the fishing-towns in all parts of the kingdom. We next come to North Wales and Gloucestershire, with respectively 1 in 1514 and 1 in 1565 of their population deaf-mutes; the districts are very dissimilar in their physical features as well as in their geographical position; the same cause for deafness can scarcely have struck them both. The next group of counties with a proportion of from 1 in 1614 to 1 in 1674, includes Buckinghamshire, Westmoreland, the West Riding of Yorkshire, Sussex, and Berkshire. Westmoreland, with its lofty mountains and barren moors, has then to sympathise with the pleasant and fertile vales of Buckingham, and the manufacturing industry of West Yorkshire with the downs of Sussex: truly the physical characteristics here are too conflicting to account for the striking similarity in these proportions. In the next gradation, namely, from 1 in 1714 to 1754, are the counties of Rutland, Suffolk, Bedford, the North Riding of Yorkshire, and Norfolk; all these are agricultural counties, and on the eastern side of the country, but there seems no reason for their greater degree of exemption from deaf-muteism than some that have been previously named. Northumberland, Northamptonshire, Cambridgeshire, Staffordshire, Lincolnshire, Hertfordshire, and Cheshire present proportions varying from 1 in 1818 to 1 in 1874, but with no apparent reason why Lincolnshire on the east, Cheshire on the west, and Northumberland on the north, should produce such similar results. The counties which contain respectively 1 in 1917, 1 in 1947, and 1 in 1958, are Cumberland, Surrey, and Leicestershire; so that Cumberland, on the Solway, is more favoured than its nearest neighbour Westmoreland, notwithstanding its greater proximity to the sea; and Leicestershire and Surrey, both inland, populous, manufacturing, and highly cultivated, have no immunity from these causes. Hampshire, Warwickshire, Oxfordshire, Lancashire, and Nottinghamshire vary in their proportions from 1 deaf-mute in 2000 to 1 in 2088; the same dissimilarity in position, and in the occupations of the people prevails here as in some of the results we have previously considered, with this notable exception, that three of these counties have large manufacturing populations, and confirm to some extent the truth of the registrar-general's observation, that "a greater degree of prevalency of deaf-dumbness seems to exist in rural and hilly localities than amidst urban and manufacturing populations." The last group of counties, showing a variation of from 1 in 2215 to 1 in 2488, comprises Middlesex, the East Riding of Yorkshire, Monmouthshire, Kent, and Durham. Here are placed together dense and sparse populations, mountainous and flat districts, and one mining county. Can anything be more dissimilar? Yet these counties are more exempt from deaf-dumbness than any other part of England, save Huntingdonshire! a small county with a rural population, and with one-fifth of its acreage fen-land. If marshy districts were productive of deafness, Huntingdonshire, Cambridgeshire, and some portions of Norfolk and Lincolnshire, should have this unfortunate pre-eminence; but if the enumerators of the Census are correct, these counties suffer less in this respect than many others, and we are instructed to seek other causes for the prevalence of the infirmity.

We do not totally reject the theory of the Abbé Daras; to a limited extent we are able to confirm it; but we are assured that topographic statistics will not enlighten us generally on the mysterious causes of deafness. We look to medical statistics and to the economy of social life to alleviate some of the evils we have been considering. That there is some connection between the physical character of a country or district and deafness there can be no doubt. In some cantons of Switzerland one deaf-mute is found in 200 inhabitants; Norway and Sardinia again present us with large proportions; and in our own country, the mountainous districts of Scotland and the Penine chain of hills produce analogous results; the plains of England, on the other hand, with a few remarkable exceptions, generally exhibit the smallest proportion of the deaf and dumb; and so it is with the plains of Luxembourg and Würtemberg, and the kingdoms of Tuscany, Bavaria, Belgium, and Holland. In Ireland, as in England, the deaf-mute is found most in the rural and least in the civic districts; the flat counties, such as Roscommon, Westmeath, Dublin, and Kildare, show the fewest cases (1 in 1935), while mountainous Wicklow has 1 in 1031, and Mayo, Limerick, Donegal, Waterford, and also Tipperary, Tyrone, and Fermanagh, the former on the coast, and all presenting mountain ranges, show an average of 1 in 1068.

Confirmatory of these views, we can with confidence adduce the following particulars: a very large majority of the pupils who have been admitted into the Yorkshire Institution have been from the district of the West, traversed by the great Penine chain. This chain commences in the Staffordshire moorlands, goes through Derbyshire (the Peak), thence into Yorkshire (Stanedge and Blackstone edge), and extends irregularly northwards (Ingleborough, Wharnside) to the Cumbrian mountains. On the east of this chain of hills, in Yorkshire, and within a few miles of them, are the large towns of Sheffield, Rotherham, Barnsley, Holmfirth, Huddersfield, Halifax, Dewsbury, Bradford, Leeds, Wakefield, Keighley, Skipton, and Settle. This mountainous district, with its towns, has supplied the Institution with 300 out of its 534 pupils; the plain of York with 35, that of Selby with 13, of Doncaster with 32, the North Riding with 37, Hull and the East Riding with 33, and the remaining number have been from localities less definitely characterised. It is true that the dense population of Yorkshire is found in the towns above alluded to, but we have already seen, and the observation has been repeatedly confirmed, that the proportion is much less in towns than in agricultural and hilly districts. A very few years ago the writer of this article visited one of the new rising towns within the influence of this range of hills, for the purpose of inquiring into several cases of deaf and dumb children resident there. He was taken into house after house, and found that he was among a wide circle of relations. At length he made the observation, that many intermarriages seemed to have occurred in the different families, and received this ominous reply: "We're all related here." "No wonder, then," he answered, "at the prevalence of deafness." And this was not a mere guess at the cause of the malady, but was the result of long-continued observation. In addition to the physical conformation or position of a district or country, the seclusion of mountainous localities is unfavourable to social developments; those who are shut out of the world by natural circumstances, or from other causes, are driven to each other for companionship and for nearer ties, and to a certain extent this may account for the prevalence of the deaf and dumb in the cantons of Berne and Argovie, in Switzerland; in Norway; in Sardinia; in Corsica, Haut-Rhin, Isère, Lozère, Cantal, and other mountainous and secluded departments in France; and also to some extent in the remote agricultural districts of our own kingdom.

America furnishes us with the following table from the census of 1850. There are other tables to which we have access, but we select this to illustrate a special point:—

Colour.	Population.	No. of Deaf and Dumb.	Proportion.
Whites	19,553,068	9136	1 in 2073
Free coloured . . .	434,495	136	,, 2956
Slaves	3,204,089	531	,, 6221

It appears that among the free coloured population 1 in 2956 is deaf and dumb; among the slaves only 1 in 6221. An American writer says, "In *every state north* of the Potomac and Ohio, the proportion of deaf and dumb among the coloured population is much greater than in *any state south* of those rivers, and in the aggregate of the two sections almost four times as great in the northern as in the southern states. It is also to be observed that in the northern states the proportion of deaf and dumb is generally much greater among the coloured than among the white population, whereas in all the southern states the case is precisely the reverse; the coloured population of the south it is well known are chiefly slaves, whereas at the north they are mostly free. If, then, the census has been correctly taken in both sections, we are led to conclude that deafness is frequently occasioned by the want of physical comforts, with which it is well known the slaves of the south are, as a body, much better provided than the free blacks of the north." The above paragraph was written twenty-five years ago, and referred to the American census of 1830; succeeding enumerations perpetuate similar proportions to those alluded to, and the observations are fully applicable to the census of 1850. This, however, is not a satisfactory mode of accounting for the greater prevalency of deafness among the coloured free population, as compared with the white race. The free coloured population of the north are far removed from the genial climate of their race, while the slave populations of the southern states are in the enjoyment of a climate adapted to their nature, and this is a more probable solution of the difficulty than that which attributes the freedom from deafness among the slaves to their possession of more bodily comforts than fall to the lot of the free coloured population of the northern states; besides, there are more deaf and dumb proportionately among the whites in the southern than in the northern states; these whites, chiefly planters and their agents, are in no want of bodily comforts, and it may fairly be inferred, that the high temperature which is favourable to the slave population of the south is pernicious to the white race, whether European or Anglo-American. Warm countries and plains, as Tuscany and Luxembourg, appear to contain a smaller proportion of the deaf and dumb than cold and mountainous ones. Change of climate has doubtless an influence in promoting a tendency to certain diseases in a new generation, and probably to some of those productive of deafness; but this result will only follow where the transition is violent, as from a cold or temperate to a hot climate, and the reverse. *To secure the highest conditions of health, every race should therefore confine itself to its own natural latitudes.*

The report of the Irish commissioners on the "Status of Disease" must be considered as one of the most valuable contributions that has ever been produced on those infirmities to which humanity is subject; such a report for the United Kingdom, when the census is again taken, would be invaluable to all institutions established for the alleviation of permanent maladies; and much assistance might be obtained from the officers of such institutions if they were previously apprised of the nature of the inquiries to be made. The science of statistics has still much to do for the deaf and dumb, but the inferences from topographical causes must always be faulty in accounting for the prevalence of the malady. Mention has been made of some anomalies which they cannot explain; they cannot account for the discrepancies between the neighbouring counties of Monmouth and Hereford, between Huntingdonshire and Worcestershire; they cannot show why the healthier province of Denmark, the island of Bornholm, should have more than double the proportion of deaf and dumb that are found in Laaland and Falster, which are considered the unhealthiest parts of the kingdom; nor why, generally, there are proportionably fewer deaf and dumb to be found in towns than in those resorts of health which citizens usually seek for their salubriousness, namely, the sea-coasts, the rural, and the mountainous districts. Some additional light will be thrown on this part of the subject in the article DEAF AND DUMB, VITAL STATISTICS OF, and some of the causes which produce and perpetuate deafness, independent of climate and locality, will therein be considered.

The following table is drawn from the census returns for 1851, reference being made to the pages in which detailed information will be found respecting each county; the portion referring to Ireland is taken from the report of the commissioners; special attention will be directed to a few points in it, chiefly in the words of the registrar-general:—

NUMBER AND AGES OF MALES AND FEMALES RETURNED AS DEAF AND DUMB.

REGISTRATION COUNTIES.	ALL AGES. Both Sexes.	ALL AGES. Males and Females.	Under 5 Years.	5–	10–	15–	20–	25–	30–	35–	40–	45–	50–	55–	60–	65–	70–	75–	80–	85–	90–	95–	100 and upwards.	Reference to Census of Great Britain.
Div. I. London	1,325	M. 783	33	124	206	78	73	60	50	33	29	27	19	16	12	9	1	3	1	..	..	..	..	page 37
		F. 542	23	103	121	61	52	39	33	28	24	21	10	4	13	2	2	3	3	..	..	..	..	
Div. II. South-Eastern Counties (Surrey, Kent, Sussex, Hants, Berks.)	836	M. 468	23	78	59	51	44	43	30	25	27	25	13	13	15	9	6	3	3	..	..	..	1	„ 134
		F. 368	19	58	60	27	37	30	25	19	21	14	17	9	17	3	6	6	..	..	..	..	..	
Div. III. South-Midland Counties (Middlesex, ex.met., Herts, Bucks, Oxon, Northampton, Huntingdon, Beds, Cambridge.)	649	M. 379	23	65	39	45	38	19	29	22	20	16	21	13	9	7	5	3	5	..	..	..	..	„ 250
		F. 270	10	45	24	41	23	24	21	13	21	8	15	7	7	6	2	3	..	..	..	..	..	
Div. IV. Eastern Counties (Essex, Suffolk, Norfolk.)	669	M. 374	26	66	40	48	33	25	23	26	21	16	12	10	11	8	5	3	1	..	..	..	..	„ 322
		F. 295	16	48	39	40	21	23	17	19	17	17	11	7	9	5	1	5	..	..	..	..	..	
Div. V. South-Western Counties (Wilts, Dorset, Devon, Cornwall, Somerset.)	1,295	M. 692	36	109	111	80	82	50	49	46	23	25	23	16	15	11	9	4	2	1	..	..	..	„ 419
		F. 603	29	100	76	80	60	40	38	44	23	21	24	20	15	12	9	9	2	1	..	..	..	
Div. VI. West-Midland Counties (Gloucester, Hereford, Salop, Stafford, Worcester, Warwick.)	1,325	M. 688	38	99	111	79	61	61	51	38	36	29	34	19	11	12	6	2	1	..	..	..	..	„ 527
		F. 637	33	110	99	63	70	58	41	40	29	22	17	17	14	11	6	3	3	1	..	..	..	
Div. VII. North-Midland Counties (Leicester, Rutland, Lincoln, Notts, Derby.)	694	M. 358	16	64	33	41	49	19	28	12	22	14	14	10	12	10	8	3	1	1	1	..	..	„ 606
		F. 336	15	55	36	29	39	30	26	25	16	20	8	9	15	5	3	5	..	..	..	..	..	
Div. VIII. North-Western Counties (Cheshire, Lancashire.)	1,237	M. 670	37	108	104	94	68	59	54	38	42	25	15	9	7	7	2	1	..	..	..	..	..	„ 665
		F. 567	27	80	101	60	50	52	44	28	40	23	17	15	13	11	4	1	1	..	..	..	..	
Div. IX. Yorkshire (West Riding, East Riding, North Riding.)	1,042	M. 565	22	98	94	69	64	47	46	35	29	18	13	10	9	7	..	3	1	..	..	..	..	„ 738
		F. 477	22	74	74	58	56	41	35	31	25	18	14	10	7	5	1	3	2	1	..	..	..	
Div. X. Northern Counties (Durham, Northumberland, Cumberland, Westmoreland.)	471	M. 253	5	43	30	20	32	21	19	16	14	12	11	8	5	6	1	1	2	1	..	..	..	„ 809
		F. 218	4	35	24	21	21	21	17	14	14	13	10	5	6	4	7	1	..	1	..	..	..	
Div. XI. Monmouthshire and Wales (Monmouthshire, South Wales, North Wales.)	771	M. 410	25	60	61	53	42	38	31	15	18	18	12	15	9	1	7	5	..	..	..	..	..	„ 893
		F. 361	16	50	63	41	38	27	25	19	20	13	13	5	13	9	4	4	1	..	..	..	..	
Scotland	2,155	M. 1198	27	195	158	152	126	110	103	76	65	47	43	21	27	17	12	9	7	1	2	..	..	„ 1043
		F. 957	32	120	137	102	99	67	83	62	68	40	39	18	46	15	8	7	9	2	3	..	..	
Islands in British Seas (Isle of Man, Jersey, Guernsey, &c.)	84	M. 46	1	9	8	6	5	4	1	..	2	2	1	2	..	3	..	1	..	..	1	..	..	„ 1071
		F. 38	2	4	2	3	3	7	4	2	5	1	1	2	..	1	1	..	..	..	..	..	..	
		M. 6,884	312	1118	1054	822	717	565	514	382	348	274	231	162	142	107	62	41	24	4	4	..	1	
		F. 5,669	248	882	856	626	569	459	409	344	323	231	196	128	175	89	54	50	21	6	3	..	..	
Total (Great Britain)	12,553	12,553	560	2000	1910	1448	1286	1024	923	726	671	505	427	290	317	196	116	91	45	10	7	..	1	

			Under 5	5–	10–	15–	20–	30–	40–	50 and upwards.
Total (Ireland)	4,747	M. 2688	120	385	401	353	578	410	221	220
		F. 2059	107	287	284	288	452	260	197	184
		4747	227	672	685	641	1030	670	418	404
	17,300	Total Great Britain and Ireland.								

The aggregate number of the deaf and dumb would be increased by a considerable addition to the column "under 5 years," but for the difficulty of ascertaining the existence of deafness, and consequent dumbness, in the early years of life, and the natural indisposition of parents to form a painful conclusion on the subject while the slightest grounds for doubt exist. A rough estimate of the omissions from this cause may be made by assuming the deaf mutes under 5 years of age to bear the same proportion to the general population of the same age as the deaf and dumb aged 5 years and upwards bear to the residue of the population. Under this assumption, the number returned under 5 years would be 1801 deaf mutes, instead of 560. In Ireland it is assumed on similar grounds that the number returned under the first quinquennial period should be 492 instead of 227. Under this hypothesis the proportion of deaf and dumb in the United Kingdom would be increased from 1:1590 to 1:1460.

In Great Britain the greatest number was returned between the ages of 5 and 15, then between 15 and 30; after 50 there is a very sensible diminution, showing that the deaf and dumb are not, like the blind, long-lived. In Ireland the greatest number was returned between the ages of 15 and 30, with a similar diminution after 50. Of the 21,487 blind persons in Great Britain, only 2929, or less than 14 per cent., are under 20 years of age, a circumstance tending to show that cases of blindness at birth are not very common; while 10,102 persons, or 47 per cent., are at the advanced ages above 60. These facts lead to the conclusion that blindness in many cases may have arisen as a natural infirmity of old age, and also show the great longevity of the blind, notwithstanding the accidents to which they are liable. Of the 12,553 deaf mutes in Great Britain, only 783, or 6¼ per cent., had reached 60 years of age, a fact showing the unfavourable position of this class as regards length of life; while those under 20 years of age, although the numbers are unquestionably deficient, amounted to 47 per cent.

The following table is taken from the thirty-fifth annual report of the New York Institution for the Deaf and Dumb, with some additions and corrections of a later date than the original document; the whole would be more satisfactory if we could in all instances quote from information of more recent dates:—

Numbers and Proportions of Deaf and Dumb in Europe and America.

Countries.	Date of Enumeration.	Deaf and Dumb.			Population.	Proportion of Deaf and Dumb.
		Males.	Females.	Total.		
England and Wales	1851	6884	5669	10398	18,070,735	1 : 1737
Scotland	1851			2155	2,888,742	1 : 1340
Ireland	1851	2688	2059	4747	6,552,324	1 : 1380
France	1853	..	..	29512	35,783,170	1 : 1212
Belgium	1835	963	783	1746	3,885,507	1 : 2226
Limburg	1835	55	35	90	165,704	1 : 1841
Luxemburg	1835	37	30	67	153,801	1 : 2295
Holland	1833	..	..	1250	2,500,000	1 : 2000
Prussia	1849	..	..	11973	16,331,187	1 : 1364
Saxony	1837	665	514	1179	1,652,114	1 : 1401
Bavaria	1843	..	..	2149	4,440,327	1 : 2066
Hanover	1833	633	478	1111	1,642,807	1 : 1479
Altenburg	1836	55	48	103	120,514	1 : 1170
Saxe-Weimar	1834	..	..	334	238,672	1 : 715
Brunswick	1839	..	..	184	259,774	1 : 1412
Bohemia	1836	..	..	2135	4,100,000	1 : 1920
Denmark	1834	337	293	630	1,225,807	1 : 1942
Norway	1835	598	493	1091	1,065,825	1 : 977
Sweden	1840	1061	938	1999	3,054,726	1 : 1528
Berne	1836	1043	912	1955	401,707	1 : 206
Argovie	1836	..	..	960	182,000	1 : 189
Leman } Switzerland.	1836	..	..	152	155,000	1 : 1019
Vand	1834	..	..	160	178,000	1 : 1112
Zurich	1840	145	121	266	232,000	1 : 872
Sardinia	1834	2825	1953	4778	3,675,327	1 : 769
Tuscany	1848	390	307	697	1,513,820	1 : 2171
Modena	1838	212	151	363	479,191	1 : 1320
United States, whites	1850	5027	4058	9085	19,557,271	1 : 2152
,, ,, coloured	1850	354	278	632	3,638,803	1 : 5750

DEAF AND DUMB, VITAL STATISTICS OF. The subject of deafness and its consequences has of late received a considerable degree of attention, but assuredly not more than its importance deserves. As one result, there is a somewhat general acquaintance with the fact that deafness prevails widely, but comparatively few, excepting those brought professionally or by relationship into daily contact with individuals so conditioned, form anything like adequate notions of the amount of deprivation under which a totally deaf person labours. Till institutions for the instruction of the deaf and dumb began to multiply, and thus to attract public notice and sympathy towards this unfortunate class of persons, it was believed that the deaf and dumb formed an inconceivably small proportion of the population; but the last census has dissipated this erroneous belief, and shown the public that there are within the limits of these islands 17,300 deaf and dumb persons. [Deaf and Dumb, Census of the.] Perhaps one cause of the general want of knowledge on this subject is the incapability of the deaf and dumb to give utterance to their own deficiencies; the very nature of their deprivation prevents their making it known and obtaining relief: thus generations have lived and died in wretchedness and obscurity.

Deafness occurs in every degree, in some cases only amounting to an insensibility to very sharp notes. Many people cannot hear the squeaking of the bat and the mouse. By holding the nose, inflating the ears, and ceasing to breathe, the ear is rendered more open to base notes, and more deaf than it naturally is to sharp notes. Dr. Wollaston constructed a small organ, whose notes began where the sharp notes of ordinary instruments end; the notes of his organ increased in sharpness till they became inaudible, though he was certain that it continued to give sound from feeling the vibrations equally with the lower notes. He thus found that some people could hear seven or eight notes higher than others, and that children could generally hear two or three notes higher than grown-up people. In some persons the accuracy of the ear is merely impaired in distinguishing faint sounds, and sounds somewhat similar; instances of this kind are particularly evident in infants, whose first attempts at speech are a very remote similarity to the sounds they hear, and become more perfect as their ear is educated, and in some cases remain imperfect through life, in consequence of defect in the organs of hearing. All imperfections of speech do not arise from imperfect hearing: an indistinct articulation may result from various other causes, from carelessness, from defective organs of speech or an imperfect formation of those organs, from irregular respiration producing hesitation, and in some instances proceeding from nervousness. The principles which regulate utterance have been practically considered and acted upon by many professors who successfully practise the cure of stammering. The discovery of these principles is due to Dr. Arnott, whose work, 'Elements of Physics,' should be consulted by all those persons who wish to ascertain the causes, moral or physical, which tend to produce defective speech. [Stammering.]

By total deafness is meant that state in which the organs of hearing are as insensible to sound as any other part of the body. To persons in this condition sound is a mere vibration, which can be felt, but very imperfectly distinguished. Yet persons who are generally considered as totally deaf, are not all equally so. There are cases where the firing of a gun is unheard though immediately near the deaf person, and others where a gun fired at a quarter of a mile distant is heard, and distinguished from the falling of a heavy weight upon a boarded floor. In some instances, the human voice in a great variety of its louder single intonations can be recognised, though the loudest reading or the highest pitch of a speaker would make no impression. The late Dr. Itard, of the Imperial Institution for the Deaf and Dumb at Paris, considered that more than half of the pupils received into that institution are of that class who hear the least; about the same proportion would be found in the English institutions. The other half comprise cases more or less of imperfect deafness, an expression which must by no means be confounded with imperfect hearing. Mr. Toynbee, the aural surgeon to the Asylum for the Deaf and Dumb, in Kent Road, London, gives as the result of an examination of 411 children in that asylum, that 245, or three-fifths, were quite deaf, while 166, or two-fifths, heard certain sounds. In all these conditions of deafness, the person is consequently *mute*, or *dumb*. Hence the expression *deaf-mute*, as used in the Continental languages, and *deaf and dumb*, as used in England and America, to designate a person so deaf as to be inaccessible by the ordinary means of lingual communication, and unable to make known his thoughts, wishes, and feelings, in our conventional tongues. As natural articulation can only be acquired by those who hear, it follows that, according to the condition of the power of hearing will be, *cæteris paribus*, the distinctness of articulated sounds. Hence, in the instruction of deaf-mutes in artificial articulation, it is generally found that those pupils who can in some degree distinguish the different tones of the human voice become the best speakers. There are certainly cases where the articulation of a totally deaf person is pleasanter to hear, softer, and less monotonous, than in some instances of imperfect deafness; but these depend upon other causes, as the natural tone of the voice, the attention of the pupil, or the care of the instructor.

When the term deafness is used in this article, it is intended to convey the idea of an absence of hearing power so total as to exclude the reception of sounds producing ordinary vibrations. Persons in this state are shut out from the usual means of converse and communication with the world; they *feel* concussions, and also vibrations, which are in direct contact with some portion of their body; but they are deaf to the loudest conversations and to all the ordinary means of direct intercourse by the living voice, as well as to the thousand charms which delight the sense of hearing: there are several degrees of this kind of deafness. Difficulty of hearing is another thing, and may be partial or temporary. It is often a concomitant of age, of local disease, or of general functional derangement. In this case the sense is only impaired; in the other it either has not existed or has been destroyed. There is a wide difference between a diminished sense of hearing and a total want of the power. Should the case be one of deafness from birth, it is called *congenital;* should the power of hearing have been lost from the supervention of some disease in the infancy of life, it may yet be as total as if from birth, but it is then a case of *acquired* deafness. In either case it is accompanied with dumbness; for those who have never heard sounds cannot imitate them, and those who become deaf before they have heard spoken words are in the same condition,—dumb. Such children are prevented from exercising that instinctive faculty of imitating sounds and speech, which constitutes one of the main pleasures and one of the most improving exercises of childhood. Again, deafness may come on at a much later period, and utterance thenceforward begins to be thick, guttural, and indistinct, so as to be frequently misunderstood; the deaf person then takes less pleasure in exercising a faculty which he finds so comparatively useless, and he becomes dumb more from choice than from necessity. This, however, is not the invariable result, but depends to some extent on temperament. Thus it was with Dr. Kitto, who gives this account of himself in his little volume 'The Lost Senses:' "Before my fall my enunciation was remarkably clear and distinct; but after that event it was found that I had not only become deaf, but spoke with pain and difficulty, and in a voice so greatly altered as to be not easily understood. I have no present recollection of having ever experienced positive pain in the act of speaking; but I was informed by one who was present, and deeply interested in all which took place at that time, that I complained of pain in speaking; and I am farther told, that my voice had become *very similar to that of one born deaf and dumb, but who has* *been taught to speak*. . . . . Although I have no recollection of physical pain in the act of speaking, I felt the strongest possible indisposition to use my vocal organs. I seemed to labour under a moral disability which cannot be described by comparison with any disinclination which the reader can be supposed to have experienced. The disinclination which one feels to leave his warm bed on a frosty morning is nothing to that which I experienced against any exercise of the organs of speech. The force of this tendency to dumbness was so great, that for many years I habitually expressed myself to others in writing, even when not more than a few words were necessary; and when this mode of intercourse could not be used, I avoided occasions of speech, or heaved up a few monosyllables, or expressed my wish by a slight motion or gesture."

When Kitto was voyaging to the Mediterranean, his kind-hearted and intelligent companions had recourse to a very justifiable artifice to induce him to use his vocal powers. His account of it, and its results, show what may be accomplished in cases of unwillingness to speak on the part of the deaf, who have once acquired the knowledge of language and the power of speech. "After much reasoning with me on the matter, they entered into a conspiracy, in which the captain of the ship joined, not to understand a word I said, otherwise than orally, throughout the voyage. In this they persevered to a marvel; but as I had much to ask, since I had not before been at sea, I made very great progress with my tongue during the six weeks' voyage, and by the time we reached our destination had almost overcome the habit of clutching a pen or pencil to answer every question that was asked me. From this time I usually expressed myself orally to those whom I knew, in the ordinary intercourse of life; but when my communication required many words, it was usually conveyed in writing. This, also, I at length dropped, and strangers only were addressed in writing. Finally, I ventured to accost even strangers with the tongue, and it was only when not understood that I resorted to the pen. At first, strangers could rarely understand me without much difficulty; but under the improvement which practice gave, my voice was so much bettered that the instances in which it was not readily understood gradually diminished, and at the present day I rarely find even a foreigner to whom my language is not clear."

The importance of inquiries into the causes of deafness has been recognised in all our institutions for the deaf and dumb, and ought to be urged upon the registrar-general when the next census for Great Britain is taken. The report on the 'Status of Disease' in Ireland has to a certain extent cleared the way and shown the value of such inquiries. The series of questions issued by the commissioners in that country is given below, and might be adopted in future investigations. They show the data on which the tables in the report were constructed. They were kindly received by the community, and in only one instance was the required information refused.

1. Whether the person was born deaf and dumb, or became so afterwards.

2. If he (or she) was born deaf and dumb, to what cause is such defect attributed by the friends or relatives; whether to fright, hereditary predisposition, or the near relationship of parents—such as the intermarriage of cousins? If attributed to any of these causes, state the degree of relationship existing between the parents, and specify the nature of the fright or accident experienced.

3. If he (or she) became deaf and dumb since birth; state at what age, and to what cause or disease has such been attributed.

4. Is he (or she) paralytic, idiotic, or in any other way mentally or physically affected?

5. Whether any other members of the family, parent or parents, or grandparents, uncles, aunts, or cousins, have been deaf and dumb, and whether they were by the father's or the mother's side. If such relatives were living on March 30, 1851, please state their names, and the barony, parish, and townland in which they were then residing.

6. Whether other members of the family, either dead or absent, such as brothers or sisters, were affected with deaf and dumbness; and if so, state the number and the position of each in the family, such as first, second, or third child, &c. If they were alive upon March 30, 1851, state where they lived: and if dead, give the date and cause of death, and the age at which they died.

7. If the person is educated, state where, and by what means such education was acquired.

8. State ——'s position in the family, whether first, second, or third child in a family of living, and dead. N.B.—State the number of living and dead required in this query.

9. If he (or she) has been married, state the result of such marriage in males and females, and whether any of them have been mute from birth, or became so by accident or disease.

The efforts made by our institutions, those of different countries of Europe, and in some instances by their governments, and by America, have from time to time thrown considerable light on the causes of deafness; but, except the Report for Ireland above referred to, nothing of importance or authority has yet been published in this kingdom; the medical and social aspects of deaf-dumbness have therefore been very partially considered. It is proposed in the present article to bring together such tables and facts as are trustworthy, and available for the purposes of comparison, together with a body of statistics which have recently been collected for the same object.

TABLE I.

PROPORTIONS OF CONGENITAL AND ACQUIRED DEAFNESS. (UNITED KINGDOM.)

	Cases.	Congenital.	Acquired.	Uncertain.
In London Asylums (Toynbee) . . .	411	313	98	
Glasgow Institution to 1855 . . .	440	351	89	
Yorkshire ditto 1859 . . .	534	378	141	15
Birmingham ditto 1859 . . .	412	319	93	
Liverpool ditto 1859 . . .	305	209	79	17
Newcastle-on-Tyne ditto 1859 . . .	155	103	52	
Belfast ditto 1859 . . .	316	273	43	
Exeter ditto 1859 . . .	239	183	56	
	2812	2129	651	32

The discrepancies in this table are not greater than might be expected, some of them may arise from imperfect knowledge on the part of those who furnished the information, but it is highly probable that if there are errors in one column they are balanced by opposite ones, and we may come to the very safe conclusion that *three-fourths* of the aggregate cases which are brought to our institutions are of congenital deafness. This is the largest number of cases that has ever been accumulated for comparison, connected with the institutions for the deaf and dumb in this kingdom.

The report on the status of disease for Ireland presents a very different proportion, which cannot be reconciled with the result obtained in any other country. It gives us a total of 4747 (excluding the dumb not deaf, the paralytic, and the idiotic); of this number 3885 were born deaf, and 535 only became so after birth; 327 cases are, however, reported as uncertain or unknown; still if these were added to the cases of acquired deafness, the proportion would remain very large of congenital cases. The Belfast institution proportions, in Table I., are to a considerable extent confirmatory of the large number of congenital cases in Ireland.

TABLE II.

PROPORTIONS OF CONGENITAL AND ACQUIRED DEAFNESS. (UNITED STATES.)

	Cases.	Congenital.	Acquired.	Uncertain.
Hartford Institution to May, 1851 . .	1060	537	463	60
New York ditto to January, 1854 . . .	1148	492	431	225
Ohio ditto to December, 1854 . . .	581	215	281	85
Kentucky ditto 1849 to 1851 . . .	85	44	32	9
Indiana ditto 1849 to 1851 . . .	195	104	82	9
Illinois ditto to January, 1851 . . .	95	44	43	8
Tennessee ditto 1849	31	19	8	4
Philadelphia ditto to January, 1853 . .	703	376	251	76
	3898	1831	1591	476
Deduct for repetitions, pupils of more than one school	22	13	8	1
.	3876	1818	158$_3$	475

This table shows that more than *two-fifths* of the cases are of acquired deafness, leaving out of consideration the uncertain ones. Three-fourths of the English pupils and not quite one-half of the American ones were born deaf and dumb. One-fourth of the English pupils and two-fifths of those of the United States became deaf by accident or disease. The European table which follows (excepting Germany) offers somewhat similar results to that for Great Britain, namely one-fourth acquired to three-fourths congenital.

TABLE III. PROPORTIONS OF CONGENITAL DEAFNESS. (EUROPE.)

	Cases.	Congenital.	Acquired.	Uncertain.
Belgium, 1835	1891	1484	407	
Duchy of Modena, 1838	353	267	86	
Tuscany, 1843 (*including uncertain) .	697	*432	265	
Groningen Institution (Holland), 1843 . .	594	409	185	
Paris ditto (France), 1829 to 1836 . .	238	171	67	
Nancy ditto (France), 1828 to 1850 . .	300	233	67	
Copenhagen ditto (Denmark), before 1856 .	88	54	34	
St. Petersburg ditto (Russia), 1836 . .	61	49	12	
Duchy of Saxe-Altenburg	103	82	21	
	4325	3181	1144	
United Kingdom, from Table I. . . .	2812	2129	651	32
	7137	5310	1795	32
Ireland Census, 1851	4747	3885	535	327
European Returns, except Germany . .	11884	9195	2330	359

TABLE IV.

PROPORTIONS OF CONGENITAL AND ACQUIRED DEAFNESS. (GERMANY.)

	Cases.	Congenital.	Acquired.
Institution of Hamburg, to 1847	57	31	26
" " Leipsic, to 1838	123	54	69
" " Dresden to 1838	38	27	11
" " Munich, 1804 to 1835	135	79	56
" " Pforzheim, 1833	62	19	43
" " Prague, 1836	165	77	88
" " Cologne, 1850	85	33	52
Total of German Schools	665	320	345

Hence it appears that in Germany more than half of the cases reported, namely, 52 per cent., were of acquired deafness, an extraordinary revelation if this result may be taken to represent the proportions throughout the deaf and dumb population of that country, and one that should lead to further investigations. As a country, the United States approximates more nearly to Germany than any other, showing an average of 42 per cent. of acquired deafness, thus:—Ohio nearly 51 per cent., Illinois 45, Hartford 44, Indiana 42, Kentucky 40, New York 38, and Philadelphia 36 per cent. These proportions are for the different districts whence the respective institutions are supplied with pupils.

This great prevalence of acquired deafness in Germany and the United States may now be usefully compared with the proportions in the United Kingdom, and with other parts of Europe. Ireland, the country *par excellence* of the congenitally deaf, presents us with only 11 per cent. of acquired deafness, and with 82 per cent. congenital, the other 7 per cent. being of uncertain origin. The four northern counties of England, represented by Newcastle-upon-Tyne, show a proportion of 33 per cent. of the pupils of acquired deafness; Liverpool, representing portions of Lancashire, Cheshire, and a large floating population from various places, exhibits 26 per cent. of its cases of acquired deafness; the Yorkshire Institution, operating chiefly within that county, has also had 26 per cent. of its cases of this class, and 8 per cent. uncertain; London and Exeter show an equal ratio, namely, 24 per cent.; the former not only provides for the metropolis, but also receives pupils from all parts of the kingdom, while Exeter is limited to the four western counties; Birmingham receives children from the midland counties chiefly, and shows that 22 per cent. of them were not born deaf. Glasgow obtains about half its pupils from Lanarkshire, and the others from all parts of Scotland, and shows that 20 per cent. of its number were not congenitally deaf, while Belfast differs but little from the Commissioners' Report for Ireland, by witnessing that only 14 per cent. of its pupils became deaf after birth.

We are thus made aware that the average of acquired deafness in Great Britain is 25 per cent., while Germany has more than double that proportion, and the United States of America show a ratio of 42 per cent. The average for Europe, excepting Ireland and Germany, is the same as for Great Britain, but offers the following anomalies: Belgium, St. Petersburg, the Duchy of Saxe-Altenburg and Nancy (France) vary from 20 to 22 per cent. only; the Duchy of Modena, the Paris Institution, and that of Groningen show respectively 25, 28, and 31 per cent., while Tuscany and Copenhagen each present 39 per cent. of acquired deafness.

These results suggest several questions for further inquiry; they cannot be accidental; variations so great must have adequate causes. If geographical position could have any influence, it might be adduced that the United States and Germany are both continental, while Ireland, with results so opposite, is insular; but Great Britain is also insular, and presents the medium ratio between the two. The Anglo-Americans, the Germans, the Britons are all of the same mixed Teutonic race; the Irish have in them the Celtic element; the isothermals which pass through the United States also enclose Germany, the south of Ireland, and the south of England. The populations are subject to similar diseases, and have equal advantages of medical aid in cases of illness—yet deafness supervenes upon one or other disease twice in Germany for once in Yorkshire, twice in the United States for once in Glasgow, four times in Connecticut (Hartford) for once in Ireland, and three times in the North of England (Newcastle) for once in Ireland. Brighton, representing the counties of Sussex, Hampshire, and Kent, presents a similar result to Newcastle-on-Tyne. Why there should be two cases of acquired deafness in Tuscany and Belgium for one at St. Petersburg, or why Belgium, itself below the average, should have two for one in Ireland, is a curious matter for future research.

The deaf and dumb are found chiefly among the poor in England, and it is probable that deafness will diminish from the great attention now given to this class, whether within or out of unions; in this respect the very poor are better cared for than those just above them, who never seek parochial aid; probably better, in the matter of medical attendance, than the well-to-do scattered rural population, and this circumstance alone will tend to prevent the supervention of deafness from suppressed eruptions in various diseases. The attention of the physician is not only directed to the cure of the present disease for which he is immediately consulted, but also to the prevention of any evil consequences which might follow such disease. Can it be possible that in the wilder districts of Germany, and in the newly settled counties of the United States—from the difficulty of procuring prompt attention, or the distance of a medical practitioner, disease is often suffered to have its way, and is then followed by consequences which the exercise of timely skill might have averted? This cause has doubtless operated, and may still operate among the rural populations of England. Why does it not produce a larger proportion of acquired deafness in Ireland?

It is observed by Mr. Buxton, the head-master of the Liverpool Institution for the Deaf and Dumb, in a paper published in the Liverpool 'Medico-Chirurgical Journal,' January, 1859: "It is certainly remarkable, that while, according to the ascertained facts, not half so many children are born deaf in any given population in the United States as in Europe, still the excessive prevalence of deafness from disease or accident, brings up the proportion of deaf-mutes to the whole population to very nearly the same ratio which is found among ourselves. In this county of Lancaster it is 1 in 2045, and for the whole white population of the United States it is 1 in 2152." The thirty-fifth Annual Report of the New York Institution compares the United States in this respect with Europe: "In Europe generally, the chances of the birth of a deaf-mute child are more than twice as great as in the United States, or 615 in a million against 278 in a million; but the chances of the loss of hearing after birth, are in Europe generally much less than in the United States, namely, 154 in a million there, and 222 in a million here; while in Ireland this proportion is only 80 in a million."

The Commissioners' Report on the status of disease in Ireland, supplies a hint respecting acquired deafness which ought to be regarded with special attention: "Comparing the congenital with the acquired cases, we find some remarkable differences, caused by localities. In the former class, the proportions are 1 in 1372 in the civic, and 1 in every 1517 in the rural; whereas in the latter the reverse obtains, that class being in the proportion of 1 in 9519 in the civic, and 1 in 11,749 in the rural—the congenital form of disease existing most amongst the rural population; and that acquired after birth prevailing most in crowded cities and towns, where children and young persons are particularly exposed to accidents, scrofulous affections and deleterious influences arising from density of population, unwholesome food, impure air, and insufficient sewerage. Moreover, the populations of cities and towns being in great part recruited by immigration from the rural districts, the deaf and dumb are more likely to remain with their friends in their native homes than those possessing speech and hearing."

Respecting the diseases on which deafness followed, we have the following information from various institutions; the heads adopted by Mr. Toynbee, though too few, have been adhered to in Tables V. and VI., among other reasons from the immense variety of causes assigned for the malady in other tables, but in Table VII. the heads of the Census Commissioners for Ireland are followed:—

TABLE V.

DISEASES ON WHICH DEAFNESS HAS SUPERVENED. (UNITED KINGDOM.)

	Fevers.					
	Scarlet.	General.	Measles.	Various Diseases.	Diseases Unknown.	Total.
London Asylum (Toynbee)	36	23	4	35		98
Glasgow Institution	18		9	19	44	89
Yorkshire ditto	29	19	13	61	19	141
Birmingham ditto	18	28	8	29	9	93
Liverpool ditto	25	11	2	17	47	102
Newcastle-on-Tyne ditto	25		3	3	21	52
Belfast ditto	18		5	20		43
Exeter ditto	15		2	10	29	56
Total	265		46	194	169	674

TABLE VI.

DISEASES ON WHICH DEAFNESS HAS SUPERVENED. (UNITED STATES.)

	Fevers.					
	Scarlet.	General.	Measles.	Various Diseases.	Diseases Unknown.	Total.
Hartford	90	103	16	143	111	463
New York	83	19	22	179	128	431
Ohio Kentucky Indiana Illinois Tennessee	49	16	50	101	88	304
Philadelphia	43	8	3	37	25	116
Total	265	146	91	460	352	1314

TABLE VII.

DISEASES ON WHICH DEAFNESS HAS SUPERVENED. (EUROPE.)

	Affections acting locally on Organs of Hearing.				Diseases and Accidents affecting the Brain and Nervous System.									Unclassified and uncertain Causes.						
	Small-pox.	Measles.	Scarlet Fever, Scarlatina, (1 Influenza).	Disease or Injury of Ears, Throat, Mouth.	Hooping-cough.	Fever.	Water on Brain, and Organic Disease of Brain.	Convulsions and Fits.	Paralysis.	Epilepsy.	Various Nervous Affections, and Fright.	Falls and Injuries.	Sundry causes.	Dysentery.	Worm Fever.	Scrofula.	Cold and Exposure.	Injuries unspecified.	Causes unspecified.	Total.
Ireland, census 1851	13	14	38	26	3	74	19	27	53	13	44	34	16	3	5	2	40	11	99	534
Belgium „ 1835	15	19	15	23	4	65	..	35	24	..	36	19	..	..	..	40	..	..	108	403
Modena „ 1838	3	6	..	10	..	31	..	2	..	..	7	2	..	..	..	7	..	..	12	80
Nancy „ 1850	..	1	1	4	1	21	..	6	1	..	5	3	..	..	..	13	..	..	14	70
Groningen „ 1845	..	7	34	10	2	56	..	30	..	..	7	..	..	..	..	33	..	..	21	200
Paris „ 1829 to 1836	..	5	4	7	..	13	..	14	..	..	2	..	..	..	..	7	..	..	15	67
Leipsic	17	4	20	2	..	4	..	3	..	..	6	1	..	..	..	8	..	..	4	69
Hamburg	..	..	..	2	1	3	..	5	..	..	1	2	..	..	..	10	..	..	8	32
Copenhagen	..	5	3	..	1	1	..	3	..	..	..	1	..	..	..	2	..	..	18	34
Cologne	..	..	..	12	..	16	..	12	..	..	2	2	..	..	..	5	..	..	3	52
Altenburg and Dresden	2	..	12	2	1	2	..	..	..	..	4	1	..	..	..	3	..	..	5	32
Prague	2	1	4	6	..	5	..	15	..	..	..	27	..	..	..	28	..	..	..	88
Yorkshire Institution	..	13	29	4	4	19	27	18	..	..	..	5	..	..	..	6	..	..	16	141
Birmingham „	..	8	18	4	3	24	12	4	..	..	2	5	..	..	..	5	..	..	8	93
Liverpool „	2	2	25	1	..	11	2	4	..	..	..	4	..	..	..	..	4	..	47	102
London (Toynbee)	..	4	36	..	..	23	..	..	..	..	..	..	..	..	..	..	..	..	35	98
Totals	54	89	239	113	20	368	60	178	78	13	116	106	16	3	5	169	44	11	413	2095

It is impossible to say from any existing data, whether boys or girls are more liable to the infirmity of deafness arising from other diseases. The Irish Report gives 419 cases of acquired deafness, in which the sex is distinguished; of these, 216 are males, and 203 females. It is, however, remarked, "that according to the present census there is rather an undue proportion of males over females in Ireland." Parents and nurses have the popular opinion that it is more difficult to rear boys than girls—that a girl will battle through a severe illness, where a boy would fail to do so—that a boy would be left with disease upon him, when a girl would be free from any secondary complaint; there are doubtless cases, where life is saved at the expense of one or other of the organs; but which sex most readily yields to the lesser deprivation to prevent the greater, must at present remain uncertain. The Yorkshire Institution has had under instruction 300 boys and 234 girls, among them were 141 cases of acquired deafness; 84 of these cases were boys, and 57 were girls—a fair relative proportion of either sex, namely, 60 per cent. of boys, and 40 per cent. of girls.

Efforts can only be made to prevent a recurring calamity, when its extent and the external circumstances tending to produce it are known; the various diseases favourable to the supervention of deafness have been named, and the next circumstance which claims notice is the age at which experience has shown the greatest liability to the influence of disease arises. It might be wished that all institutions supported by the state or by public benevolence were required to record such facts, as far as possible, for the general welfare, then would our information afford more conclusive results—

TABLE VIII.

AGES AT WHICH HEARING WAS LOST.

	New York.	Hartford.	Philadelphia.	Glasgow.	Yorkshire.	Ireland.	Belgium.	France; Paris and Nancy.	Germany; Leipsic, Dresden, Cologne, and Prague.	Groningen.	Totals.
Under one year	53	70	22	10	26		54	10	41		286
1 yr. & under 2	76	128	27	10	22		84	55	80	32	514
2 „ „ 3	68	102	20	13	12	120	62	29	47	48	521
3 „ „ 4	25	41	18	9	17	109	67	23	27	38	374
4 „ „ 5	26	41	9	4	7	76	38	15	13	21	250
5 „ „ 6	25	17	9	3	6	38	23	5	6	17	149
6 „ „ 7	18	13	2			36	35	4	4	16	128
7 „ „ 8	4	10	2	1		32	12	8	1	8	78
8 „ „ 9	6	2	3			21	5		1	3	41
9 „ „ 10	2	2			1	11	6				22
over 10 „	4		1	1	2	15	15			2	40
Ages not given	124	37	3	38	48	45					295
	431	463	116	89	141	503	401	149	220	185	2698

Provided the due proportion of the 120 under the age of 3 years, for Ireland, were distributed under 1 and 2 years, it would be at once manifest that the most fatal time of a child's life for the acquisition of deafness is that between 1 and 2 years of age, and that the next most dangerous period is between 2 and 3; after 5, the liabilities decrease materially. It will be evident then, that great care should be exercised by parents during the continuance and development of all diseases to which children are subject during the first quinquenial period of their life, and more especially with reference to those diseases which are shown in the previous tables to be favourable to the supervention of deafness.

The tendency of deafness to run in families is well known. The Report of the Belfast Institution for 1854 shows, on a list of 68 pupils, *one* instance of 5 (all) in a family deaf and dumb, *four* cases of 3 in a family, and *ten* cases of 2 in the same family. The 534 pupils who have been received into the Yorkshire Institution have arisen out of 416 families; of this number, 342 had only a single case of deafness among their children, the other cases arose out of 74 families—45 of which had *two* each (90), 18 had *three* each (54), 7 had *four* each (28), and 4 had *five* each (20), making 192 cases. Of the Birmingham pupils, 412 were received out of 369 families; of these, 305 had each *one* deaf and dumb, 43 families had *two* each (86), 15 had *three* each (45), 4 had *four* each (16), one had *five* (5), and one had *seven* (7). The 239 pupils of the Exeter Institution have been received out of 164 families, 149 were single instances in the family, 20 families had each *two* (40), 12 had each *three* (36), and 4 had each *four* (16). The thirty-fourth Report of the Glasgow Institution shows that in 298 families there was *one* case in each, in 36 families, *two* in each (72), in 20 families, *three* in each (60), in 3 families, *four* in each (12), in one family *five* (5), and in one *seven* (7), making 454 cases of deaf and dumb in 369 families. The Report of the London Asylum for 1859 shows a selected list of 23 families, containing 160 children, of whom 105 are deaf and dumb.

The thirty-fifth Report of the New York Institution contains much interesting information of the tendency of deafness to run in families, with especial reference to the pupils of that and other institutions in the United States, but space forbids our extracting any portion; enough has been shown above to illustrate this part of the subject, except that it seems desirable to insert the following table (in col. 411) from the census of Ireland, which is introduced in the Report by these observations: "In 3415 instances of deaf-mutes, concerning whom the particulars were available, we have acquired the information shown in the annexed table, with respect to the numbers of which the families consisted in which one or more mutes were born in each. From it we perceive that families consisting of five, six, seven, and eight, presented the greatest number of mutes. The family position of the deaf and dumb is also shown in it, as well as in the foregoing Table. In one instance, two mute children, one the tenth and the other the last, occurred in a family of twenty-nine, all born of the same parents; the twenty-ninth child, now aged fifty-five, is still living in the county of Cork."

We have now to consider some of the causes which are productive of deafness. The laws which influence the physical condition of mankind are becoming better known than they were formerly, and all new discoveries which tend to the amelioration of "the ills which flesh is heir to," are appreciated and applied as opportunities arise. Some of these evils are transitory, and yield to the efforts made for their relief; others, though permanent, may in many instances be divested of their worst character; some are to a large extent preventible, and among this class deafness, both in its congenital and acquired forms, may be placed. The condition of things necessary to bring about such a result may be aided and encouraged by wise legislative enactments, by increased knowledge, and a willingness to observe the laws which govern and regulate life and health. When it is generally admitted that obedience to these laws is favourable to soundness of body and mind, and that a disregard of them brings its own punishment in the form of disease, and early death, we may hope that many of the afflictions under which mankind labour will pass away or suffer diminution.

TABLE IX.

Showing the number of Children born in each Family, and the number of the Children Deaf and Dumb.

Number in Family.	Number Deaf and Dumb.								
	One.	Two.	Three.	Four.	Five.	Six.	Seven.	Eight.	Total.
One	121								121
Two	146	8							154
Three	224	20	8						252
Four	308	35	12	2					357
Five	338	41	14	1	1				395
Six	364	44	12	7					427
Seven	377	43	17	8	2	1	1		449
Eight	320	58	22	4	3	1		1	409
Nine	233	27	20	5	1	1			287
Ten	152	28	9	5					194
Eleven	93	13	11	3					120
Twelve	63	5	4	1	1				74
Thirteen . . .	29	1	1		1				32
Fourteen . . .	14	2	1	2					19
Fifteen . . .	5	2	3						10
Sixteen . . .	7	1	1						9
Seventeen . .	2								2
Eighteen . . .	1								1
Nineteen . .	1		1						2
Twenty . . .	2	1							3
Twenty-nine. .		1							1
Unknown . .	92	4	1						97
Total . .	2892	334	137	38	9	3	1	1	3415

The principal ascertained causes of congenital deafness are hereditary transmission, consanguine marriages, feebleness of constitution in the parents, scrofula, the influence of locality, and the ill-health of or accident to the mother during pregnancy. The experience of our institutions at home and abroad, and the researches and opinions of scientific men have accumulated evidence on all these causes which entitles them to separate consideration. The results of such researches and opinions will be given, but only to such an extent as can be borne out by the confirmatory experience of the writer. Cases similar to those to be adduced are of constant occurrence in all institutions for the deaf and dumb, and might be multiplied to an almost indefinite extent. The physical history of deafness has attracted much attention during recent years, and the surmises of a quarter of a century ago, have now in many instances, become established facts.

Several cases of the transmission of deafness through three generations are known to the writer of this article; evidence of a similar nature from other sources is proof sufficient that one of the main causes of deafness is *Hereditary Transmission.* "It has been clearly ascertained," says Mr. Harvey, 'On the Ear,' "that the most common cause is a strumous and delicate habit of the body, generally hereditary." An important table is given in the census returns for Ireland, "showing the result of hereditary predisposition, or family peculiarity in the production of congenital muteism. From its arrangement we learn that in 329 instances, numbering 471 persons born in families some of the previous members or collateral branches of which were mute, 249 persons were born deaf and dumb where the disease appeared to come from the father's side; whereas in the other division, where the affection was transmitted through the female line the number amounted but to 222. Among the examples which are given illustrative of this table we find the following: "In cases of single congenital muteism, where the relatives were also deaf and dumb, there were by the father's side—in two instances an uncle and an aunt, in one case two grandaunts, in one instance two aunts, in one case an aunt and a cousin, in another case two nieces and a cousin, in another instance six cousins; in three cases there were four cousins; in eleven instances, three cousins; and in nine cases two cousins, all deaf-mutes. Where two of the family were affected with congenital deaf-dumbness, in two instances four cousins were in a similar condition, in two cases three cousins were deaf and dumb, and in four instances two cousins were thus afflicted. Where three cases of congenital deaf-dumbness occurred in the same family, in one case the great-grandfather had been deaf and dumb, in two instances two grand-uncles had likewise been deaf-mutes, and in five cases two cousins were in a similar condition.

Where the relationship came by the mother's side, there were in cases of single congenital muteism, one instance of a niece and one cousin; eight cases where three cousins were deaf and dumb; and fourteen instances where two cousins were thus affected. In cases of two mutes in the same family, we find that in one case two aunts were also deaf and dumb, in one case three cousins, and in four cases two cousins laboured under the like defect. Where three mutes occurred in the same family, in one instance an uncle and an aunt, and in another a half-uncle and an aunt, were deaf and dumb; and two cases presented two cousins also deaf and dumb." The thirty-fourth Report of the Glasgow Institution (1855) gives cases similar in character to the above, from the records of that institution, and every school of the kind could supply facts bearing on the hereditary transmission of deaf-dumbness.

Consanguine Marriages are, next to hereditary transmission, perhaps the most fertile source of deafness. Every institution in the kingdom bears witness to this fact in the numerous cases of pupils who are the offspring of first cousins. And deafness is not the only evil result; idiotcy, blindness, feebleness of frame, insanity, the death of children in early life, and various physical imperfections, such as club-foot, hare-lip, and spinal deformities are too often the result of such marriages. Mr. Buxton says, "In an inquiry which I made sometime ago, from a large number of persons, I found that about every tenth case of deafness resulted from the marriage of cousins;" and Dr. Peet, of the New York Institution, confirms this ratio; the writer's experience is very similar, and has extended to other mental and physical defects, as well as to deafness, as a common result of such marriages. The Irish Commissioners report on this branch of their inquiry as follows: "Among the predisposing causes of hereditary disease, the too close consanguinity of parents has long been looked upon as paramount, and consequently, an inquiry was made as to its probable effect in producing deaf-dumbness. Returns of this nature must be expected to be deficient; still, 170 instances were recorded, in which the parents were related in the degrees of first, second, or third cousins. The result of these intermarriages was 109 cases of *one* in a family deaf and dumb, of which ninety-four were congenital and five acquired; three were dumb only, and seven dumb and idiotic. Thirty-seven cases of congenital and one of acquired deaf-dumbness occurred, where *two* of the family were affected, including four out of the fifteen cases of twins already specified. Of the remainder, seventeen instances occurred in which *three* of the same family; and three where *four* in the one family were deaf and dumb. In one of the instances where *six* in the family were deaf and dumb, and in the cases of both seven and eight deaf and dumb in families, the parents were also nearly connected. These numbers include, not merely the living upon the night of the 30th of March (when the census was taken), but all the children living or dead, born deaf and dumb of the same parents."

A writer in the 'British Quarterly Review' (No. LVII.) has taken up this subject in its many bearings, and as our own experience confirms his statements, we do not hesitate to quote them: "Popular opinion and scientific induction equally lead to the impression, that although one marriage between near relatives may be unattended by evil consequences immediately perceptible, yet it is very rare that the second or third is so innocent. There usually arises amongst the children resulting from such unions a tendency to disorders, functional or organic, of the nervous system, or of the nutritive organs, tending in the former case to unsoundness of mind, and in the latter to conditions bordering on scrofula, or an allied affection. M. Devay found in the children proceeding from 121 consanguine marriages, twenty-two cases of sterility (actual and virtual), twenty-seven cases of various deformities, and two deaf-mutes. Dr. Boinet knew five idiots in five different families sprung from this sort of marriage. A celebrated lawyer, married to a cousin, lost three children from hydrocephalus. A manufacturer at Lyon, similarly married, had fourteen children; eight died of convulsions at an early age; only one survived; the remainder died of scrofulous affections. In our own circle of acquaintance we know several families where there is an idiot child, or where several of the children have the most strongly-marked nervous peculiarities, to which the parents and the ancestry were strangers, and for which there seemed to be no plausible reason, except that their parents were cousins, and that the families had been in the habit of intermarrying." The writer of this article has, for several reasons, preferred giving the above extracts to detailing similar cases which have come within his own observation, but he is acquainted with more than fifty instances in which cousins have intermarried, and whose children have been visited with one or more of the evils above alluded to; he, therefore, regards such marriages as the transgression of a natural law, which is followed by its own punishment.

The records of every institution for the deaf and dumb, and the observations of individuals who have applied themselves to this inquiry, show that constitutional feebleness in one or both parents is a cause of deaf-muteism. In every institution there is a larger proportion of orphans and half-orphans than would be found among the children in an ordinary school, and also a larger proportion of parents labouring under some physical infirmity. On one of these points, the New York Report, to which we have before referred says, "We have noticed that a large proportion of our pupils, perhaps one-fifth, had lost one or both parents before they came to school; but we have no data to show that this is a larger proportion of orphans and half-orphans than would be found on an average in a promiscuous collection of children who were not deaf." To this testimony it may be added, that one-fourth of the children in the Yorkshire Institution (1858–9) had lost one or both parents in early life, a sure indication of feebleness of constitution, and that a certain number of those living were of delicate frame.

Scrofula in parents, transmitted to the offspring, is generally admitted to be a cause of deafness; it is well known to the medical attendants of all institutions for the deaf and dumb, that strumous affections are common among the pupils, and that they are by no means confined to the congenitally deaf; in some of the cases of children born deaf, unhealthy parents have doubtless originated the disease, independent of any hereditary deafness. Scrofula and consumption, and scrofula changing into one of the protean forms of consumption, or exhibiting itself in glandular swellings, can scarcely fail to be transmitted from parent to child. At the same time there are many apparently healthy parents, and also parents known to be free from any disease, whose children are unhealthy, which can only be accounted for on those obscure physiological conditions which constitute what is called by breeders of animals, a bad cross.

The influence of *locality* has often been assigned as one of the predisposing causes of deafness. A spontaneous disease seems to arise in such cases which may become hereditary, and an accidental circumstance of this nature may favour an acquired peculiarity which may be transmitted to generations. Several cases are on record of the successive inhabitants of damp houses having deaf and dumb children, who were previously free from any predisposition to deafness. Our own experience has shown that a large number of the children of the Yorkshire Institution were born on the eastern side of the mountainous district, extending from Derbyshire, through Yorkshire, into Cumberland; the institutions of Birmingham, Manchester, and London, have received pupils from the other side of this chain of hills; and thus to a certain extent the theory of the Abbé Daras, and the correctness of the observations in the Irish census alluded to in the preceding article, are confirmed. The goitrous neck in Derbyshire, in the Swiss Alps, and in certain parts of Hindustan, is attributed to local influence, and the offspring of parents thus afflicted are subject to those hard tumours about the neck, ears, and chin, while many of them are deaf and dumb.

The *ill-health of, or accident to the mother during pregnancy*, is often mentioned as one of the causes of deafness in the offspring. Mr. Buxton, the principal of the Liverpool school for the deaf and dumb, mentions some of these cases, which we give in nearly his own words. "The Irish Census Returns record 127 instances in which the deafness of the child was ascribed to fright, experienced by the mother before its birth; but though subsequent inquiry was made into a sufficient number of these cases, in order to obtain some trustworthy information as to the causes of fright, no result was arrived at which was worthy of detailed publication. . . . At Leipsic, in three cases of congenital deafness, the misfortune was ascribed to the fright of the mother, and in three others to mechanical violence—one before birth, and two from difficult delivery. At Groningen, the mothers of sixteen affirmed that they had been frightened during pregnancy by the hoarse cries of a deaf-mute, or pretended deaf-mute. Two women of distinguished families, and of delicate constitution (!), ascribed the misfortune of their children to the impression received by witnessing the performance of the drama—the 'Abbé de l'Epée.' Another French lady of rank, assigned the deafness of her child to the lively emotion (!) which she experienced from the circumstance of king Louis Philippe having considerately offered her a chair, upon some public occasion, when she was evidently unfit to bear the fatigue of standing. M. Herbert Valleroux, in his work on Deaf-Dumbness, mentions that several examples of the effect of mental impression are known to him, one instance being that of two children, whose mother ascribed their privation to a paroxysm of anger, experienced during her pregnancy. In America, instances are known in which a mother supposed the deafness of her offspring to be owing to such causes as the following: stopping the ears that she might not hear the screams of an elder child undergoing a surgical operation, or the cries of a dying child; frights received from deaf-mutes or from persons pretending to be such; the sympathy or shock excited by seeing deaf-mute children for the first time; and the fear when one child has become deaf by disease or accident, that the next comer might be *born* so. The latter reason has been frequently assigned as one of the causes for the existence of more than one deaf child in the same family; as if excessive anxiety and fear begot the very evil it dreaded, and thus 'ran to meet what it would most avoid.' A woman living in one of the eastern counties, who had three children born deaf, stated that before the birth of each, she had been alarmed by a deaf and dumb beggar. After the birth of the third, she never saw the man again, and all the children she had afterwards possessed their hearing perfectly. Another woman who had three or four deaf children out of six, stated that before the birth of the first she was summoned to the help of a neighbour who had been seized with a fit, which rendered her speechless, and shortly proved fatal. The sight so affected the expectant mother, as to deprive her of speech for several hours; her eldest child, who was subsequently born, proved deaf and dumb, as were also her third and fifth; the sixth died before the fact could be ascertained; the second and fourth heard perfectly." Some of the above cases are cited in the Report of the New York Institution, where it is very properly remarked, that "it may allay the anxieties of mothers on this subject to learn, that whether we call such cases of deafness *effects* or mere *coincidences*, they are comparatively infrequent, amounting at the most to one case in twenty."

The only other branch of inquiry coming within the scope and space assigned to this article, is that of the *marriage* and *intermarriage* of the deaf and dumb. How truly does the experience of all our institutions prove the correctness of the observation in the Census Report for Ireland—"the defect is seldom transmitted direct from deaf and dumb parents to children." How few of the pupils in our schools are the offspring of deaf and dumb parents; there are exceptions, but these only prove the position. The Principal of the Hartford Asylum (Connecticut) says—"In only a few instances have we known it transmitted from parents to their children." The Principal of the New York Institution says— "We can show that it is much the most common for the children of deaf-mute parents to possess the faculties of which their parents were deprived." Among the 534 pupils of the Yorkshire Institution there have only been two cases in which one of the parents was deaf and dumb, and two instances in which both parents laboured under this infirmity; in one of the former class there were three of the children deaf and dumb, in one of the latter all the offspring, four in number, are deaf and dumb.

Thirty-four of the former pupils of the Yorkshire Institution are known to have entered into the marriage state; there are probably many others; of this number twenty-four have married deaf and dumb partners, one of these instances is that just recorded of all the offspring being deaf and dumb, but no others are known; the other ten are married to hearing and speaking persons, and we have heard of no case of a child among them labouring under the defect of the deaf and dumb parents. Most of the parents are still young, and they may yet have children inheriting the parental defect.

We conclude then that there are no sufficient reasons why the deaf and dumb should not marry, unless we lived under laws which were designed to exterminate deafness, or to prevent every possible mode of its transmission. Discretion must guide mankind, understanding must keep them in this point as in many other social and physical relations with which laws cannot interfere. We have seen that deaf and dumb offspring are neither the inevitable nor the ordinary result of marriages in which one of the parties is deaf and dumb, but in the case of intermarriage the liability is greatly increased and strengthened. The physical weakness which produced the deafness under which the parents labour has nothing to overcome it, as in the case of only one of the parents being deaf and dumb; and if either the husband or the wife is a member of a family which contains other deaf-mutes in its direct or collateral branches, the probability of deaf and dumb children being produced is thereby greatly augmented. The cases of transmission for two or three generations, known to the writer of this article, are all of this class—all among families which have the peculiar hereditary predisposition to this defect. It is well known, and daily observed, even by non-professional observers, that forms of the body, features, deformities, and physical habits are transmitted from parent to child; that intellectual characteristics are frequently transmitted, that moral qualities and tendencies to vice are inherited from parents, and re-appear in their sons and daughters.

Twenty-five years ago there were few statistical documents to assist us in our inquiries as to the physical condition of the deaf and dumb. Since that time most of the institutions in the kingdom have collected data, and some of them have published the results of their researches. The article written for the 'Penny Cyclopædia,' in 1837, suggested a series of heads as a foundation for such investigations. We are thankful to acknowledge how thoroughly the subject has been taken up in the New York Institution, and the aid we have derived from its thirty-fifth report, so frequently referred to. Mr. Buxton, of the Liverpool Institution, has been a successful labourer in a similar direction; and the reports of the Belfast, Glasgow, and Exeter Institutions have also supplied valuable matter, of which we have availed ourselves in the course of this article.

DEAF AND DUMB, EDUCATION OF THE. Before the practicability of instructing the deaf and dumb was admitted, it was generally supposed that instruction by means of the conventional signs and sounds denominated language was limited to those who could hear. The idea never entered the mind of man, or if it did it was as instantly rejected, that the deaf-mute was not, on account of his deafness, bereft of his reasoning faculties, nor excluded from the means of connecting thought with symbols. It was not till the 16th century that the possibility of carrying forward the process of education in the absence of all hearing, received any serious consideration. Even at the present day there are many persons who are at a loss to conceive not only how abstract notions, but even how the names of palpable objects are made known to the deaf, and at a still greater loss to imagine how they can be brought to use language to express their ideas. Having themselves obtained knowledge through the ear, having been accustomed to impart their thoughts by oral communications, they seem to forget that the mind has intelligence in all the senses connecting it with the external world, and conveying knowledge to those higher faculties which compare, discriminate, and judge. In an intelligent though uneducated deaf person, an observer would find these processes going forward, though confined indeed to a very limited sphere, owing to the poverty of his knowledge, but still knowledge, deduced from observation, limited also by the want of a conventional mode of expressing it. The existence of the reasoning power being thus evident, the means to cultivate it would be the next object for philosophic investigation. That Aristotle had never made these observations and investigations is evident, or he would not have come to that absolute conclusion which excludes the deaf from all participation in knowledge. Among other people of ancient times these unfortunate beings were the objects of a species of proscription, being supposed to labour under the curse of heaven. Previous to the time of Justinian the Roman laws maintain an absolute silence upon the deaf and dumb. They speak frequently of deaf persons, not being dumb; and also of dumb persons not being deaf; but never of those labouring under both these deprivations. The Code (lib. vi. tit. xxii. l 10) mentions the deaf and dumb in a manner express and special. Five classes of persons labouring under one or both of these deprivations are established. Those who from their birth were deaf and dumb were legally incapable of making a will, or of manumitting a slave, and laboured under other civil disabilities.

The reader will find in the work of C. Guyot, of Groningen, which is a dissertation written in Latin on the legislation relative to the deaf and dumb down to 1824, all that relates to this part of the subject, with a list of authors. Saint Augustine, in the fourth century, declares that the deaf and dumb are shut out from obtaining religious knowledge, remarking "that deafness from birth makes faith impossible, since he who is born deaf can neither hear the word nor learn to read it;" and many respectable ecclesiastics in the time of the Abbé de l'Epée openly condemned his undertaking. The benevolent abbé also informs us that parents considered it a discredit to have deaf and dumb children, and they believed that they fulfilled every claim such offspring could have on them by merely supplying their animal wants, concealing them from the eyes of the world within the walls of a cloister, or in some other obscure abode. He also asserts that in some uncivilised countries the deaf and dumb were in *his* time regarded as monsters, and were put to death as soon as their calamity was ascertained. So that we find naturalists, legislators, divines, philosophers, and even parents, agreeing in the impracticability of conveying knowledge otherwise than by speech, and thereby excluding the deaf and dumb from all means of intellectual improvement.

From the advantages which instruction has afforded to a certain proportion of the deaf and dumb for more than half a century, a tolerably correct estimate may be formed of their capabilities for improvement. The deaf-mute living in society, but without instruction, must be regarded as one of the most solitary and melancholy of beings. He is shut out from all but the most imperfect intercourse with his species; and the very intellect by the possession of which he is raised above the lower creation serves only to heighten his calamity, and to render the sense of his deprivation more acute. His perceptions of external objects are indeed accurate but superficial, and confined to a very small sphere. Of the various arts by which the necessaries and conveniences of civilised life are produced, he can have no knowledge beyond that which is included in the range of his own vision. Animal desires he feels, and he is led by the conventional usages of society to the performance of moral duties and the avoidance of open and flagrant crime. Thus he becomes experienced, as other human beings are, in what is right or wrong. He sees that virtuous actions have a certain amount of reward, in the opinions of good men; for he learns to discriminate between those whose actions are proper and those who do wrong; and again, he sees that in many cases vice meets with disapprobation and punishment among mankind. How this kind of experience shall affect his own conduct must depend not only on the circumstances in which he is placed, as to example and the moral influence of those with whom he has to associate, but also on his own natural tendencies.

The performance of moral duties implies the exercise of intellectual faculties; and from his birth the deaf-mute makes use of his reasoning powers. He is subject to changes of purpose, to changes of feeling, to the passions, the pleasures, and the infirmities common to his species; he is sensible of kindness, and he gives proofs of affection. That such is the state of the deaf and dumb when uneducated might be proved by the observations of their parents, friends, and instructors, in hundreds of instances. That such must necessarily be the case, supposing them not to be idiots, it would be easy to show. We affirm, in contradiction to those who contend that deaf-mutes are naturally more debased than other men in intellect and in morals, that there is not an individual deaf-mute now under instruction—improving, and thereby evincing rational faculties—who, previous to instruction, however disadvantageous the circumstances which attended his earlier years, did not evince moral sentiments and intellectual operations. We have traced the history of many of this class in different ranks of society, from the period when the deprivation under which they have laboured was first ascertained to the time when their direct education has commenced; and we have found invariably that mixture of good and evil in their actions and tendencies which is seen amongst other children. We have also had sufficient proofs of the exercise of intellect even while they were in a state of childhood.

At the same time, it must be acknowledged that the deaf and dumb are generally inferior in their moral and intellectual powers to those who do not labour under the same defect. But this inferiority is only one of degree, and may be satisfactorily accounted for, in accordance with the opinions above expressed. Andral has described the state of an uneducated deaf and dumb person, and to a certain extent we can adopt his sentiments. Experience and observation among this class of persons would have induced this accomplished pathologist to have bestowed on them even a more liberal endowment. "The deaf-mute exhibits in his intellect, in his character, and in the development of his passions, certain modifications which depend on his state of isolation in the midst of society. We find him remain habitually in a sort of half-childishness, and he has great credulity; to balance this he is like the savage, exempt from many of the prejudices which we owe to our social education. In him the tender sentiments are not very deep; he appears not to be susceptible either of lasting attachments or of lively gratitude; pity touches him but feebly; he is an entire stranger to emulation; he has few enjoyments and few desires; and the impressions of sadness but slightly affect him. This is what is most commonly observed in deaf mutes; but this picture is not universally applicable. Some, more happily endowed, are remarkable for the great development of their intellectual and moral nature; there are others, on the contrary, who continue in a state of complete idiocy." ('Dictionnaire de Médecine,' article 'Surdi-Mutité.') This last remark of Andral's requires some qualification. Deaf and dumb persons who possess intellectual faculties are no more liable to become idiots than others whose organs perform their appointed functions. Their powers may remain undeveloped; they may be ignorant of everything which depends on intercourse with mankind; their reasoning may be inconclusive, and their inferences erroneous from their confined observations; but still their mental powers will be called into action, and they will be, to a great extent, under the control of their reasoning faculties. This is not the case with idiots: in them there is a deficiency, more or less, of self-government, and of intellectual control. There are, at the same time, numerous cases of idiots who are *dumb;* not, however, in consequence of deafness, but from their incapacity to understand the meaning of language, to imitate it, and to apply it. These persons cannot be classed with *the deaf and dumb.* It may be this class to which Andral particularly alludes in the latter part of our quotation; for he qualifies his remark in some measure by adding, "The difference in the intellectual and moral nature of man is often primitive, and independent of all external influences." Of the same opinion with ourselves we find Degérando, Bébian (the successor of Sicard), Piroux of Nancy, and all the more successful teachers of the deaf and dumb of the present day, in this country and throughout Europe and America.

Passing over the miracles of our Saviour—when the deaf were made to hear and the dumb to speak, by immediate inspiration—we learn from the Venerable Bede's 'Ecclesiastical History,' quoted by the Abbé Carton in his 'Annual of the Deaf and Dumb and Blind,' published at Bruges in 1840, that a deaf man was taught to pronounce words and sentences by John, Bishop of Hagulstad (Hexham), afterwards known as John of Beverley (BIOG. DIV.), in the year 685. This, and other works of healing, were attributed by the simple-minded Anglo-Saxons to some miraculous power conferred upon the good and sensible bishop for his holy life; but enough is recorded to show that the process was the gradual one afterwards pursued by most of the early professors of the art of teaching speech to the deaf and dumb, and even now followed in some of our institutions. The bishop made the sign of the cross on the mute's tongue, which ceremony is now dispensed with, and then pronounced the Anglo-Saxon word ȝea, yea, upon which his tongue was loosed, and he uttered the sound, or a sufficient approach to it to induce the clever bishop to pronounce letters, syllables, words, and afterwards sentences, which the deaf man imitated, a slow but certain process towards success.

The next mention we meet with of the capacity of those born deaf to receive instruction, is in the writings of Rodolphus Agricola (born in 1442) of Groningen. He does not inform us who was the parent of the art; but he mentions in his posthumous work, 'De Inventione Dialecticæ,' that he had himself witnessed a person deaf from infancy, and consequently dumb, who had learned to understand writing, and, as if possessed of speech, was able to note down his whole thoughts. The truth of this relation was doubted by Louis Vives, of Valentia, who wrote in the beginning of the 16th century; but there is as good reason to put trust in Agricola's account as to join in Vives's disbelief. (See the treatise, 'De Anima,' of Vives, L. ii. c. 'De Discendi Ratione.') Not long after the death of Agricola, and during the life of Vives, the theoretical principles on which the art rests were discovered and promulgated by the learned Jerome Cardan, of the University of Pavia, his native place. He was born in 1501, and died in 1576. Cardan thus expresses himself: "Writing is associated with speech, and speech with thought; but written characters and ideas may be connected together without the intervention of sounds, as in hieroglyphic characters." (See 'Journal of Education,' No. VI. p. 204.) The most noted early practitioner of the art of instructing the deaf was Pedro de Ponce; this fact is authenticated by two of his contemporaries, Franciscus Vallesius and Ambrosius Morales. Ponce was a monk of the order of St. Benedict, at Oña. Morales, in his 'Antiquities of Spain,' thus speaks of Ponce: "He has already instructed two brothers and a sister of the constable, and he is now occupied in instructing the son of the governor of Aragon, deaf and dumb from his birth, as the others were. What is most surprising in his art is, that his pupils speak, write, and reason very well. I have from one of them, Don Pedro de Velasco, brother of the constable, a written paper, in which he tells me that it is Father Ponce to whom he is indebted for his knowledge of speech."

The register of deaths of the monastery of the Benedictines of San Salvador de Oña, informs us of the death of Pedro de Ponce, in August, 1584; it records of him that he "was distinguished by his eminent virtues, and that he obtained a just celebrity throughout the world in instructing deaf-mutes to speak." John Paul Bonet, also a Spaniard, published a work on this subject nearly forty years after the death of Ponce. He had probably heard of the success which had been attained in this infant art; and from tradition he might have gained some glimpses into the methods Ponce had pursued; but it appears that he was unacquainted with those methods in any serviceable form, as he represents himself as the inventor of the modes which he pursued, including mimic signs, writing, dactylology, and the oral alphabet. His work, which was in after-years useful to De l'Epée, is entitled 'Reduccion de las Lettras, y Arte para enseñar á hablar los Mudos.' [Bonet, Biog. Div.] During the time of Bonet, the art was also making some progress in Italy. Several individuals are mentioned in Degérando's work who were more or less engaged upon the subject. Affinate wrote at the commencement of the 17th century on a manner of teaching the deaf to speak; and Fabricius of Acquapendente wrote upon the phenomena of vision, voice, and hearing; and on speech and its instruments. In 1616, Jean Bonifacio published a treatise on the language of action. Pierre de Castro, who was chief physician to the duke of Mantua, instructed the son of Prince Thomas of Savoy, but it is not known on what principles. Pierre de Castro died in 1663. About 1670, Father Lana-Terzi, a Jesuit of Brescia, who is described as "an ardent investigator of nature," employed himself on the subject of giving language to the deaf, and teaching the blind to read and write; his work on natural history, published in 1670, contains some philosophical remarks on the mechanism of speech, so it is concluded he taught on the articulation system.

Many first discoveries were probably made of this art: several of them originated with, or were carried forwards by, philologists, and particularly among the schemers for a universal language. In England, John Bulwer's name must stand prior to that of any other individual as an author on the subject, and his views, as given in 'Philocophus,' are sound and practical. It has often been attempted to place Dr. Wallis at the head of this list of discoverers in England; but Bulwer's 'Philocophus, or the Deafe and Dumbe Man's Friend,' was published in 1648,—several years before Wallis commenced even his treatise on speech, and he did not publish his claims as an instructor of the deaf till 1670. We find on consulting the above-named work of Bulwer's, that chap. xv. contains the relation of Sir Kenelm Digby as to what Bonet had accomplished in Spain; and there is no doubt but Wallis obtained information from the same source, as he was in constant correspondence with Sir K. Digby. [Bulwer, Biog. Div.]

A degree of credit is certainly due to Dr. Wallis for the pains he took to systematise what had been done up to this period, and to bring the philosophy of language to bear upon the art. His two great objects, as stated in a letter to Mr. Boyle, were "to teach a person, who cannot hear, to *pronounce the sound of words*," and to teach him "to *understand a language*, and know the signification of those words, whether spoken or written, whereby he may both express his own sense and understand the thoughts of others." Writing, reading on the lips, and speech, the manual alphabet, logical induction, the natural signs—acquired from the deaf—were the means he made use of. From the accounts which have come to us, he succeeded in his purpose. His pupil, Daniel Whalley, was exhibited before the Royal Society in the year 1662. The priority of his invention was disputed by Dr. William Holder, rector of Bletchington, who asserted that he had, in the first instance, taught Popham, one of Dr. Wallis's pupils, to speak. Holder published his 'Elements of Speech, with an Appendix, concerning Persons Deaf and Dumb,' in 1669, which was some years after Wallis's first writings and practice had been made known.

In the same year in which Wallis published his inventions for the deaf, 1670, George Sibscota issued a little work on the subject, entitled the 'Deaf and Dumb Man's Discourse.' He had learned from the writings of Franciscus Vallesius to what extent Ponce had succeeded. Very little can be gleaned from this work, which consists chiefly of reasoning and theory.

The next author on the subject whose work we shall notice is George Dalgarno. His treatise, though full of the conceits of learning, is essentially practical, and even at the present day it might serve as a guide to an intelligent person who desired to become an instructor of the deaf. The date of this little work is 1680. [Dalgarno, Biog. Div.] Dalgarno announces on the title-page of 'Didascalocophus,' that his treatise is the first (for aught he knows) that has been written on the subject. He commences by showing that a deaf man is as capable of understanding and expressing a language as a blind man, inasmuch as that all information is conveyed to the mind through the bodily organs. He goes too far, however, in attempting to show that the deaf man has even superior advantages in acquiring languages to those of the blind. Dalgarno's alphabet is exhibited in the article Dactylology.

We will now trace the earlier progress of the art in Holland. Peter Montans offered some remarks on the instruction of the deaf so early as 1635. F. M. Van Helmont published in 1667 a small tract entitled 'Alphabetum Naturæ,' in which he shows how the deaf may be made to understand the motions of the organs of speech, much after the manner of others who are taught to read. His book is remarkable for some whimsical opinions on the nature and origin of language; and he mentions instances of the result of his system, too improbable to be received even by the most credulous. In 1690, John Conrad Amman, a Swiss physician, residing at Haarlem, undertook the instruction of a girl, deaf and dumb from birth. He seems not to have been aware how much had been accomplished in this art; his own success was decisive; and while his work was in the press, he became acquainted with the writings of Wallis, and entered into correspondence with him. His essay, entitled 'Surdus Loquens,' the speaking deaf man, was published in Latin. His methods were founded on articulation. Amman requires that his pupil's organs of speech shall be rightly formed; then, he says, "my first care is to make him to sound forth a voice, without which almost all labour is lost; but that one point, whereby deaf persons do discern a voice from a mute breath, is a great mystery of art, and, if I may have leave to say so, it is the hearing of deaf persons, or at least equivalent thereto; viz., that trembling motion and titillation which they perceive in their own throat whilst they, of their own accord, do give forth a voice. That the deaf may know that I open my mouth to emit a voice, not simply to yawn, or to draw forth a mute breath, I put their hand to my throat, that they may be made sensible of that tremulous motion when I utter my voice; then I put the same hand of theirs to their own throat, and command them to imitate me; nor am I discouraged if, at the beginning, their voice is hard and difficult, for in time it becomes more and more polite."

Amman goes on to explain how he communicates the pronunciation of letters singly and combined, in a way sufficiently plain for any intelligent person to follow his plan. He concludes by saying, "If there occurs to anybody anything either too hard or not sufficiently explained, he may expect a more full edition; or else let him repair to the author, who, according to the lights granted to him, will refuse nothing to any man."

At the commencement of the 18th century the art began to attract the notice of the learned of Germany. Very early in the 18th century Kerger commenced the work of instruction at Liegnitz, in Silesia. His sister was associated with him in his labour. He used drawing, pantomime, articulation, and writing; it is uncertain whether he employed dactylology, but he speaks highly of mimic language. Contemporary with Kerger was George Raphel, pastor and superintendent of the church of St. Nicholas at Lüneburg, who had six children, and among them three daughters who were deaf and dumb. Paternal affection made him an instructor of the deaf; he succeeded beyond his hopes, and wrote an account of his proceedings for the benefit of others. His work was published at Lüneburg in 1718. Other teachers in Germany were Otho Benjamin Lasius, the Pastor Arnoldi, and Samuel Heinicke. Lasius confined himself almost solely to the teaching of visible language, as reading and writing, associating the forms of the words with the ideas they were intended to convey. It is said that his pupil made a satisfactory progress, and that at the end of two years she could answer important questions on religious subjects. Arnoldi used the means more commonly employed,—articulation, drawing, dactylology, writing, and natural signs. Heinicke was the instructor at Leipzig of an institution founded by the elector of Saxony in 1772; it was the first established by any civil government. He had announced previously to this time that in the course of six weeks he had taught a deaf and dumb person to answer whatever questions were proposed to him. He used those means which had been employed by previous instructors, and he also placed instruments in the mouths of his pupils to regulate the positions of the vocal organs in emitting sounds. He claimed the honour of invention on many points, and guarded with strict secresy some of his proceedings. He had adopted the philosophic system of Kant, and published some writings relating to it. He is said to have been a man of considerable talent in the instruction of the deaf and dumb, and of an active and indefatigable spirit. In his controversy with the Abbé de l'Epée he certainly gained little credit, either as a teacher of the deaf or as a philosopher. He was the great promoter of the vocal system of teaching the deaf and dumb which is still retained in most of the German schools. Heinicke's grave mistake was, that *articulate words* were the only medium by which *thought* could manifest itself; that the written word is only the representative of articulate sound; that a deaf mute can never become anything more than a writing machine without an acquaintance with spoken language.

France commenced this art later than the other enlightened nations of Europe. Indeed she opposed its progress by those philosophic prejudices which in other countries had been refuted by actual experience. A deaf-mute from birth, named Guibal, had made his will *in writing* so early as 1679, and proofs of his knowledge and intelligence were produced in court, so that it was confirmed. It is unknown who had been his instructor. About the middle of the 17th century several individuals in different parts of France turned their attention to the subject. Those of whom we know most are Father Vanin, a priest of the Christian doctrine; Rodrigue Péreire, a Portuguese; Ernaud, the

Abbé Deschamps, and the Abbé de l'Epée. Father Vanin employed design both for giving information on sensible objects, and also in an allegorical way to illustrate abstract and intellectual ideas. Very crude and erroneous notions must have resulted from a system so imperfect, and so little capable of extensive application. The first person who excited general attention in Paris was Péreire; he obtained the approbation of the Academy of Sciences, to the members of which learned body he exhibited the progress of his pupils. His processes were made a secret even to the members of his family; he however offered to disclose them for a suitable consideration, which was withheld, and the nature of his system is only imperfectly known at the present day. His pupils were highly instructed, more highly perhaps than any of an earlier or a subsequent period. A judgment may be formed of the efficacy of his methods from the report of a committee of the Academy of Sciences, where it is stated that his pupils were able to understand what was said to them, whether by signs or by writing, and that they replied *vivâ voce*, or by writing; they could read and pronounce distinctly all sorts of French expressions; they gave very sensible replies to all questions proposed to them; they understood grammar and its applications; they knew the rules of arithmetic, and performed exercises in geography; and it appeared that M. Péreire had given them, with speech, the faculty of acquiring abstract ideas. The two best known of Péreire's numerous pupils were Saboreux de Fontenai and D'Azy d'Etavigny. The former of these two has written an account of the means pursued by his teacher, for which we must refer to the work of the Baron Degérando before mentioned. It appears that Péreire employed articulation, reading from the lips, the manual alphabet, and a method of syllabic dactylology. By this latter instrument of instruction he was enabled to communicate very rapidly with his pupils, and by the frequent use of words in different combinations a knowledge of their value was imparted to them. Thus the frequent recurrence of words through so rapid a mode of intercourse assimilated the acquisition of language to the ordinary process with hearing and speaking persons. The channel of communication being established, and a copious knowledge of words acquired, the art of the instructor would be little more difficult than that of ordinary education. A few years after Péreire's methods had received the approbation of the Academy of Sciences, Ernaud presented to them a memoir on what he had attempted for the deaf and dumb. The society gave him encouragement, but it appears that the pupil brought under their notice was not far advanced in instruction. Ernaud's attempts were more particularly directed to measures of physical relief; he revived the sense of hearing in some cases where it had been partially lost, and he asserts that he had never met with an instance of total deafness. Articulation was the principal means he employed. In 1779 the Abbé Deschamps published his 'Cours Elémentaire d'Education des Sourds-Muets.' To the education of this class of persons he devoted his life and his fortune. He followed in the track of Amman, giving the preference to articulation and the alphabet upon the lips, over the methodical signs of the Abbé de l'Epée. His establishment was at Orleans, where he received paying pupils, and instructed the indigent gratuitously.

In tracing these early steps in the instruction of the deaf and dumb, we have attended more particularly to the working parts of the different methods by which such instruction was intended to be conveyed. We have passed over the various philosophic theories with which some of these methods are incumbered, because they are either forgotten, or rendered obsolete by recent discovery. Much learning was anciently wasted on subjects in themselves trivial, mysterious, or incomprehensible, yet to such researches we owe much valuable knowledge. It seems that no investigation into the laws of nature, however absurd or unattainable the immediate object of such investigation, is utterly without reward. The alchemists of olden times, though failing to discover the wonderful stone for which they sought, found out new properties, new substances, and new combinations, which cheered their labours and conferred direct benefits on society. So, with many of the writers we have noticed, their speculations, though wild, have not been in vain; the useful parts of their systems have been retained, and are now diffusing good among the class for whom they laboured.

The Abbé de l'Epée was one of the most active and benevolent labourers in this task of humanity. He brought into systematic operation the notions which had previously prevailed on the possibility of conveying intellectual knowledge to deaf-mutes, and added to these stores of experience from the resources of his own highly-gifted and well-disciplined mind. He certainly succeeded to a greater extent than any of his predecessors in enlisting the public feeling in his favour, and in drawing the attention of sovereigns to one of the most unquestionable works of charity and of mercy; yet his name has not been suffered to descend to posterity unstained by obloquy, nor undimmed by malignant censure. It appears that accident first made him acquainted with the deaf and dumb; benevolence led him to the consideration how their wants might be supplied. He remembered that his tutor had once proved to him that there is no more natural connection between metaphysical ideas and the articulated sounds that strike the ear, than between the same ideas and the written characters that strike the eye, and that his tutor drew this conclusion:—that it was as possible to instruct the deaf and dumb by writing, always accompanied by visible signs, as to teach other men by words delivered orally, along with gestures indicative of their signification.

In the early part of De l'Epée's career he met with the work of Bonet before mentioned, and the enlarged treatise by Amman, 'Dissertatio de Loquela.' With these guides, aided by the enthusiasm which formed a part of his character, he pursued his task vigorously and with a certain amount of success; not with the success of some of his forerunners in the art, who had devoted themselves entirely and for years to individual pupils. The abbé had a large number of pupils to whom he devoted his life and patrimony. Every one who has been a teacher knows well the degree of success which he may expect if his whole mind is concentrated upon the improvement of a few individuals, and the difficulties he may anticipate if his attention is divided among a great number of pupils. The abbé appears to have made use of articulation in one part of his career, for he wrote a treatise on the mode of teaching by this auxiliary; this treatise was chiefly derived from the writings of Bonet and Amman. He employed dactylology also in a subordinate degree. Pictures he found an uncertain resource, and only useful in the earlier stages of instruction. Methodical signs, writing, and natural signs, were the means on which he chiefly depended for the conveyance of intellectual knowledge.

In acquiring a second language, those who already possess one have at command a comparative grammar which informs them to a certain extent of the value of words in certain connection with others; but the deaf have no such advantage; their natural and uncultivated language—gesture—is powerless for everything but the expression of their most ordinary wants; they have no separation of their ideas into classes, such as produce the parts of speech in more perfectly formed languages. Adelung mentions the inhabitants of the countries on the Asiatic continent as having "but one sound to signify *joyful*, *joy*, *to rejoice*; and that through all persons, moods, and tenses. The mere radical ideas are set down together, the connecting links must be guessed at. They form plurals as children do, either by repetition, as *tree, tree*, or by adding the words *much* or *other*, as *tree much*, *tree other*." Mithridates, v. i. p. 18. Thus it is with the naturally deaf, the radical idea is all that their gestural language is capable of expressing until modified by those arbitrary forms of speech which are the accessories of every polished language.

In order to represent the good abbé fairly, we will take two examples of his process of teaching, from the translation of his own work, published in England in 1801. He is about to teach the present tense of the verb *to carry*. "Several deaf and dumb pupils being round a table, I place my new scholar on my right hand. I put the forefinger of my left hand on the word *I*, and explain it by signs in this manner: showing myself with the forefinger of my right, I give two or three gentle taps on my breast. I then lay my left forefinger on the word *carry*, and taking up a large quarto volume, I carry it under my arm, on my shoulder, on my head, and on my back, walking all the while with the mien of a person bearing a load. None of these motions escape observation. I return to the table, and in order to explain the second person," &c. All this is as good as any process employed in the present day, and illustrates the application of *natural* signs. The next example is one in which signs of reduction are employed. M. Linguet had observed that the deaf and dumb were demi-automatons. The abbé addressed him, and a short time after Linguet visited the abbé and his pupils. "I requested him," says the Abbé de l'Epée, "to propose at his fancy, some abstract ideas to be delivered by methodical signs to the deaf and dumb. As, out of compliment, he referred the choice to me, I addressed him to this effect:—'*Intellect, intellectual, intelligent, intelligence, intelligibility, intelligible, unintelligible, intelligibly, unintelligibly, unintelligibility*: here are nine words all generated from "intellect," to be expressed by distinct methodical signs. *Comprehensible, incomprehensible, comprehensibly, incomprehensibly; Conceivable, inconceivable, inconceivably; Idea, imagination, imaginable, unimaginable; Faith, credence, credible, credibly, incredible, incredulous, incredulity*: here, learned sir, is a cluster of abstract ideas, which shall be left to your option.' After some further little contest of politeness, he selected the word *unintelligibility*, doubtless conceiving it of greater difficulty than the rest. It was instantly rendered to the pupil and written down. While he was viewing it with eyes of amazement, I thus resumed, 'Barely to produce the word you specified, learned sir, is a mere nothing. I will now unfold to you the means taken to prompt it by methodical signs; the exposition will not detain you long. Five of these signs were fully sufficient to designate the word; and you saw with what celerity they were given. The *first* signifies "not an external but an internal action;" the *second*, "of reading the mind, that is, exhibiting the disposition of apprehending the things proposed to it;" the *third* announces "the possibility of this disposition," whence arises the appropriate noun-adjective, *intelligible;* which, being a concrete quality, is converted into the abstract by a *fourth* sign, forming *intelligibility*; and a *fifth* sign being added for negation, *unintelligibility* is produced.'" By this and other examples M. Linguet was convinced that his expression was inaccurate and inconsiderate; but we need not follow out the examination which the pupils underwent in his presence. We have quoted this example in order to show the mechanical nature of the signs employed. That these were well qualified for dictation of words was sufficiently proved in the abbé's experience, but the words might be produced by the pupil from the signs of the teacher, without their being understood, just as an ordinary schoolboy, unused to Latin exercises, might, from the dictation of his teacher, produce examples without understanding a single idea which they contained.

In distinguishing gender, the abbé says, "The gender is explained by putting our hand to our hat for the masculine, and to the ear, the part to which a female's head-dress extends, for the feminine." In the English institutions the hand is placed to the beard to denote the masculine, and drawn along the forehead, in allusion to the parting of the hair, for the feminine. The following is the generally received sign for singular and plural: "The elevation of the right thumb designates the singular, the motion of several fingers the plural." The following is also good: "To express doubt, we turn our head to the right, a *yes*, and to the left, a *no*; which of the two will take place we cannot tell; we shall know only by the event." Many similar examples might be adduced: how superior are these to "twirling two fingers round each other while declining, that is, while descending from the first to the sixth," to signify the term *case*; or "the left hand under the right for the noun-substantive," and "the right under the left for the adjective," will be readily perceived.

We do not regard the success of the Abbé de l'Epée as complete, but we are satisfied that he pursued his methods with openness and candour, and with the single desire of promoting the moral and intellectual advancement of the deaf and dumb. Heinicke of Leipzig, and Péreire of Paris, must be regarded as his rivals, but he invited them to a discussion of the merits of the various systems, which they declined. While the good abbé, with that frankness which formed a beautiful feature in his character, solicited the examination and the judgment of the learned upon his methods, his rivals shrouded their proceedings under a veil of mystery. The abbé devoted his life and whole fortune, excepting a bare supply for his own wants, to the service of the class whom he had taken under his protection. Péreire refused to disclose his methods, except for a large recompense; and Heinicke, in addition to receiving payment from the rich, had four hundred crowns annually allowed him by the grand duke of Saxony. Both these persons made the art they professed an interested speculation; the Abbé de l'Epée only tolerated the rich—he was proud of being the instructor of the indigent. His successor, the Abbé Sicard, carried forward the principles of De l'Epée; he instructed his pupils in the elements of composition, a branch of their education comparatively new, and in which Sicard most completely evinced his superiority over his master. Sicard at first conducted a school at Bordeaux; on the death of the Abbé de l'Epée, Sicard was called to fill his place at Paris. The philosophical opinions and penetrating views which Sicard maintained and practised are well developed in his 'Cours d'Instruction d'un Sourd-Muet,' in which is developed the plan on which he conducted the education of his celebrated pupil Massieu. He followed the leading principles of De l'Epée, particularly in employing methodical signs as one of the chief instruments of instruction; he considered well the nature of language, and by his clear and analytical methods of sensible illustration, he contrived to make the leading principles of grammar familiar to his pupils. In the latter years of Sicard's practice he thought more favourably of articulation, as a means of rapid communication between master and pupil, than he had done at the commencement of his career. The Baron Degérando says of his most popular work, "When we read the 'Cours d'Instruction d'un Sourd-Muet,' we almost fancy that we are reading a kind of philosophical romance. It borrows its forms, and creates a similar interest; we find in it something of the romance of the Arabian Theophail ('Le Philosophe Autodidactique'); something which appears borrowed from the pictures of Buffon, the statue of Condillac, and the Emilius of Rousseau; it is a soul which has hitherto slumbered, which awakes; an intelligent life, which begins to develop itself, amid a variety of scenes, to the voice of the instructor; it is a kind of savage, strange to our customs, who is initiated into our ideas, our knowledge, and at the same time into our language. The Abbé Sicard enlarges upon each of these progressive stages, and spreads over them the charm of a drama; he paints with warmth the uncertainties and the joys of the master and the pupil; and he succeeds in thus showing, in an animated picture, definitions and processes which appear the most barren in their nature; he gives a shape to the most abstract notions; it might be said that the Abbé Sicard is the *painter of syntax* and the *poet of grammar*. This work went through several editions, and we need not be surprised at it, for it is not to the deaf and dumb alone that it may be profitable."

Of the 'Theorie des Signes,' a work founded on the principles of the Abbé de l'Epée, we can only give a faint sketch. It is a kind of dictionary, in which the expressions of the face, and the attitudes of the body, for the communication of certain ideas, are described. The arrangement is not the ordinary alphabetical form of a dictionary, but a kind of logical order "more conformable to the nature of things, and the growth and expansion of ideas." The work is divided into twelve classes of things, adopting in each class an alphabetical order corresponding to the French language. These classes are arranged as follows:—

1. Signs of names of the most common objects, and such as come under observation during infantile years; these are the parts of the body, clothing, food, beverages, a town and its parts.
2. Vegetables, comprising forest-trees, shrubs, fruit-trees, culinary vegetables, medicinal herbs, wild plants, &c.
3. Minerals—gold, silver, copper, brass, lead, tin, iron, &c.
4. Of man—ages of man, relationships, school, institution, college, officers, domestics and servants of a house, tradespeople, mechanics, merchants; the liberal arts; titles, dignities in towns, cities, and states, and their functions; terms of war; ecclesiastics, and monastic functionaries.
5. Of God, angels, saints.
6. Of the elements; of fiery, luminous, and watery meteors; the firmament, earth, cardinal points, signs of the zodiac.
7. Parts of the world; names of nations, empires, kingdoms, republics, capitals, principal islands, &c.
8. Numbers, measures, weights, time, money, exchanges, commerce.
9. Organic qualities of man; abstract organic qualities of man; maladies of the body.
10. Qualities of matter; such as strike the senses of man, dimensions, shapes, surfaces, extent, quantity, lines, angles.
11. Physical actions of man, such as are expressed by verbs.
12. Intellectual and moral actions of man, expressed by verbs, nouns, adjectives, and adverbs.

These are the divisions Sicard adopted for his nomenclature, which occupies nearly the whole of the two volumes comprising the work, the latter portion of which is purely grammatical; in it the different parts of speech are considered, not only under a general view, but under certain divisions which indicate their value, and assimilate those which bear a relationship to each other; thus adverbs of *manner*, of *number*, of *place*, of *quantity*, of *quality*, of *interrogation*, of *affirmation* and *negation*, of *time*, of *doubt* and *inquiry*, and of *comparison*, are distinctly and separately treated of. Without questioning whether the classification adopted in the twelve divisions of the 'Theory of Signs' be the best, we may see in such a classification the kind of gradations needful for supplying the deaf with an extensive nomenclature; and though few instructors would make the work a practical one, so far as to adopt the system of methodical signs there developed, yet, as a text-book, it unfolds a plan which any teacher may modify according to his own views. We think the work is less valued than it deserves to be, for as signs will to a certain extent be always in use among the deaf and dumb, especially in those institutions where they are educated, the theory of signs would be found of great use as a work of reference to all teachers. We need not panegyrise the Abbé Sicard; his exertions for the deaf and dumb are well known in this country, which he visited during the political troubles of France in 1815; his merits are acknowledged wherever the education of the deaf is pursued. We have sometimes been surprised that the 'Cours d'Instruction d'un Sourd-Muet' has not been translated into our language. Independent of its novelty and interest as connected with its more immediate design, its gradual unfolding of a great mind involved in moral and intellectual darkness, by a metaphysician of high endowments, presents some interesting psychological facts which would make it serviceable in general education; the illustrations of language and the development of ideas are just such as an accomplished and lively teacher would desire to place before his pupils, to assist in conveying to their minds a just estimation of the value of words, and the knowledge which they serve to impart.

In England, after the time of Bulwer, Wallis, Sibscota, and Dalgarno, the art slumbered for many years. It was revived by Henry Baker, the naturalist and microscopical observer, who taught dumb persons to speak, and of whom it is recorded by Dr. Samuel Johnson, that he once "gave him hopes of seeing his method published;" he however kept the plan he followed secret. Of the extent of his success we know nothing, but it is said that the names of some of the first families in the land are among those of his scholars. [BAKER, HENRY, BIOG. DIV.] About the year 1760, Thomas Braidwood had an academy at Edinburgh, where he taught the dumb to speak, and cured impediments in the speech. He professedly pursued the plan of Dr. Wallis, as developed in the 'Philosophical Transactions.' Articulation was therefore the chief instrument of instruction, and the principal medium of communication between the pupil and teacher. In 1783 Braidwood removed his school to Hackney, where he enjoyed for many years a deserved reputation for his successful application of the discoveries of his predecessors. [BRAIDWOOD, BIOG. DIV.] Under him the late Dr. Watson became acquainted with those principles which he brought to much greater perfection than his predecessor, and developed in his work on the 'Instruction of the Deaf and Dumb,' and which he practised during his long superintendence of the Asylum in Kent Road, London. Indeed Dr. Watson was to Mr. Braidwood what Sicard was to De l'Epée; the disciples in each instance gave solidity and permanence to the systems of their respective masters.

The teachers of the deaf and dumb of the present day are divided, as formerly, into two classes, namely, those who make articulation, and reading on the lips, their main auxiliaries of instruction, but who generally use dactylology and pictures also; and those who depend more upon natural or imitative signs, and who also employ writing, pictures, and dactylology. In only one school in England, that of London, is articulation systematically followed; in all the provincial schools it is discarded as a main instrument of instruction, though in a few it occupies a very subordinate place. In teaching the deaf and dumb, the first object in view is to impart to him the language of his country; the second is grounded on this—to fill his mind with intellectual, moral, and religious truth. These two objects are generally made to accompany each other; the communication of knowledge in easy language familiarises him with the forms of language, and the exercises themselves are made the vehicle of valuable knowledge. In teaching vocal sounds to the deaf, the eye and the sense of touch are chiefly employed; the letters of the alphabet are classified; the sounds that are labial, dental, lingual, guttural, nasal, and those which are combinations of two or more of these, are taken in such an order that the pupil may discern differences in their similarities, and in some instances the organs of speech are shown, by means of drawings, in the required positions for the emission of certain sounds.

The open mouth, the widening lips, and part of the tongue, may be shown in the pronunciation of *a*, the nearly closed lips, hiding both tongue and teeth in *u*; in *b* the compression of the lips can be accurately shown, and the labial-nasal sound *m*, may be said to be exhibited in the closed lips, and by a line of dots to show the emission of air through the nostrils. It must be clearly understood that such drawings are chiefly useful in showing the positions of the organs.

Accompanying the exercise, the pupil must be made to notice the external organs of speech in his teacher, to feel the vibration with his own hand which sound creates in the trachea, and also to feel those emissions of breath which are caused by the production of certain sounds. He will be made to imitate such utterance; and by the exercise of patience and ingenuity on the part of the teacher, ingenuity chiefly directed to those little arts which refer to the mechanism of speech, and patience that will not be discouraged by repeated failures, the pupil will succeed in imitating what he observes, and in time he will accomplish what is required. In Wilkins's 'Essay towards a Real Character' there is a diagram of the positions of the organs for producing vocal sounds, which may be consulted with advantage, though not in every instance accurate. While a pupil is engaged in acquiring the articulated sounds he may also be employed in writing letters which they indicate, and in learning their shapes by the eye; he may also be initiated in the manual alphabet. In teaching the deaf articulation, the *names* of the letters are not taught, but their *powers;* thus in the sentence, "Fame can charm all;" the vowel *a* has a different sound in each combination, and each sound must be taught and practised separately till it is acquired, and so on with the other vowels; the consonants are classified too, and whether a breathing is required as in f, th, s, sh, p, &c., or a murmuring as in v, th, z, b, d, g, &c., care is taken not to call them by their ordinary alphabetical names. In Edgeworth's 'Practical Education' the consequence of teaching hearing children alphabetic sounds is thus exhibited. A child having learned the alphabet, and having to read the words, *Here is some apple pie*, would, it is fairly enough suggested, pronounce thus: *Acheare ies esoeme apepele pewie.* This is not exaggerated; with hearing children, constant reading corrects the tendency; but numerous instances of this nature must and do occur among the deaf, who in many cases retain the first impressions they receive as to the sounds of letters.

Another primary auxiliary in the education of deaf-mutes is that modification of the language of gesture called natural signs. In this language the deaf and dumb take great pleasure; if unrestrained, it would be their only mode of communication with each other; and they appear to find in its resources all that is necessary to give life and force to their ideas. The quick changes of countenance which they exhibit, the sparkling eyes, the lighted-up features, the sarcasms, the sensibilities thus expressed; the transitions "from grave to gay, from lively to severe," all faithfully portrayed in the ever-varying index of their mind, speak at once in favour of this language as the truest mirror of their thoughts, hopes, wishes, and feelings, and inform us that this language is nature's most perfect, most expressive interpreter. To this rude though powerful mode of intercourse, which all the deaf possess in a higher or lower degree, those who are more intelligent add signs of description, by which they are able to explain facts and circumstances which have been brought under their observation. The teacher takes advantage of this method of communication to add to their stores of knowledge, to enrich and extend the sphere of their thoughts, to give them new food for the mental operations, all of which may be accomplished during the time that words and the language of their country is imparted to them. Thus a conventional language is formed which assists in their intellectual culture, increases their happiness, and shows them in some degree the connection which exists between themselves and the objects by which they are surrounded. In many institutions this use is made of signs: new knowledge is most effectually communicated by their aid. The sixteenth report of the New York Institution for the Deaf and Dumb furnishes an example of which we can avail ourselves to show the great benefit of signs in the business of instruction. The natural signs for the words in which the sense of the sentence is comprised will readily occur to the reader. "Let it be supposed that an instructor should wish to produce the following sentence: 'A horse runs away with a boy, throws him off, and kills him.' It is not at all probable that such a combination of circumstances would occur at the moment, and thus enable him to take his pupils to the window and point them out. He must have recourse, then, to signs. It is immaterial what selection of place and circumstance is made, provided only that the facts to be enunciated are clear and prominent. The scene of the occurrence may be laid in the city. The boy is riding slowly along, staring at the multitude of new objects which meet his view, and wholly forgetful of his horse. Suddenly a military company appears from a cross-street, with drums beating and colours flying. The horse becomes frightened and beyond control: he dashes through the street at a furious rate. The boy clings to the saddle, but is at length thrown with violence on the pavement. The blood is seen spouting from his mouth and nostrils. People gather around and raise him up. They feel his pulse; but it has ceased, and the breath of life is gone: the boy is dead. During this description, the class are looking most intently on the instructor. Every eye is fixed, and every countenance full of expression. He has now obtained everything for which he laboured. Their ideas and notions of the fact are as clear and explicit as his own; and it only remains to express them by written language. To imagine, as some have done, that this process of writing is a *translation* of signs into language, is wholly erroneous. It is no more a translation than the same expression of a speaking child would be, when the casualty should actually occur." To this we will only add, that the rapidity with which such a description is conveyed to the pupils is inconceivably great, and takes very little longer than the communication of the occurrence vocally, in its shortest form. But the disadvantage attending such a mode of intercourse, when a language has to be taught, is not recompensed by its rapidity, as the words and the syntax of spoken languages are not employed in such descriptions; the pupils are consequently left ignorant of the grammatical construction of sentences. It is therefore found necessary to unite natural and descriptive signs with writing or dactylology, in the use of which the idiom of the maternal language is preserved. Most of the English and American institutions employ the signs we have described; this auxiliary is also employed at Paris, at Yverdun, at Vienna, Toulouse, Nancy, Besançon, Bachtelen, Pisa, and at several other institutions. Mimic signs will always possess this advantage to the deaf over every other mode of intercourse, that they present to them a lively picture, in which facts and circumstances can be constantly and instantaneously reproduced; they address themselves immediately to their perceptive powers, and lead them intuitively, and by a direct process, to form just connections and conclusions; while our conventional tongues, whether addressed to them by articulation, by writing, or by dactylology, act upon them by the circuitous paths of association, and the habit which they long follow of converting our language into their own.

One important influence which the mimic language exercises on the intellectual development of the deaf has yet to be noticed. This results from its employment among themselves. Much of the knowledge which the younger pupils of an institution obtain is through this medium. The lessons of the teacher for many months have less influence on the minds of his pupils than the intercourse with their associates. This is a powerful argument for bringing up the deaf and dumb in public rather than in private schools. Independent of the stores of knowledge which an assemblage of deaf-mutes bring from the districts in which they have lived, the fruits of their personal observation and experience, the events that have occurred within the walls of the institution, particularly as they bear upon actual occurrences, are handed down by mimic and descriptive signs from one generation to their successors; and a very valuable and available store of intelligence is thus preserved, which at the same time contributes to the formation of character and familiarises the pupil with the use of this species of language. Respecting *methodical signs*, we need add nothing to what has already been said of the method of the Abbés de l'Epée and Sicard. We think they are not much used at the present time in the education of deaf-mutes.

Writing is employed in all institutions; it is an art which is soon acquired sufficiently well for all school purposes. At first it engages the attention of the pupils, while they endeavour to form on their slates those combinations of letters, the meaning of which has been conveyed to them; and thus it relieves the teacher and employs a new set of faculties in the pupils. This slow but permanent repetition of their lesson assists in fixing the forms, and the matter conveyed by them, in their minds. At a later stage, it exercises similar influences upon them in a higher degree; and it is, besides, the instrument by which they give permanency to their thoughts and observations in those *compositions* which form an important exercise in these seminaries. It is also the medium to which they chiefly have recourse among strangers, and among their friends, if they find their articulation is imperfect, and their signs not well understood.

Dactylology is another auxiliary in almost universal use. For a more particular view of the utility and value of this instrument of instruction we refer to the article DACTYLOLOGY.

Pictures and the art of drawing are valuable helps at the commencement of instruction. A collection of all objects cannot be made, nor can objects be so conveniently referred to as representations of them. Either by reference to pictures or real objects, the first lessons are conveyed to the deaf, and they impart an interest to the exercises which no other means could supply. To those who have not well considered the subject, it is a matter of surprise how much of language can be represented by a graduated series of engravings, or even by the rude sketches which a teacher can draw upon his tablet whenever they are wanted, to elucidate the subject which he is desirous to impress on the minds of his pupils. In the work of Bébian, the successor of Sicard

('Manuel d'Enseignement Pratique des Sourds-Muets'), the pictorial art is employed to exemplify substantives, their gender and number, adjectives, the cardinal numbers, fractional numbers, verbs neuter and active, personal pronouns, prepositions, articles, and degrees of comparison; many other portions of language may be explained by diagrams. Drawing is thus of essential service, and the pupils often have recourse to the advantages it offers for any communications which they think will be better comprehended through its medium than others. This art is therefore encouraged, and in nearly all institutions direct instruction is given to the pupils from an early period of their education.

The auxiliaries we have now indicated are used for the conveyance of all kinds of knowledge; in some branches of study one may have a preference to others, from its being better adapted to their elucidation. Thus geography will always be taught from maps, geology from sections, geometry from diagrams; pictures will be used to describe historical events; and signs will be in requisition for the illustration of the arts and trades of men, as well as for showing the manners and customs of distant nations. Collections of metals, minerals, vegetables, animals, animal substances, vegetable substances, are of the highest value, and furnish direct evidence of properties and changes which cannot be described. It will even be necessary occasionally to call in the assistance of the workshop and its implements, the laboratory and its apparatus, in order to perform experiments, and to exhibit processes before their eyes; and while the excitement prevails, to make use of the opportunity to communicate not only knowledge, but the primary aim of all instructors of the deaf and dumb—*language*. Having the latter, the attractive form in which knowledge is presented will raise in them a desire to possess this also, and the object of the teacher is fully accomplished.

It has been already mentioned that Heinicke was the great promoter in Germany of the system of vocal articulation and reading on the lips still retained in the German schools, and also adhered to in the London asylum, but only exceptionally followed in the other schools of the United Kingdom. In the year 1844, in consequence of some statements put forth by the secretary of the Massachusetts Board of Education, the directors of the New York Institution felt themselves called upon thoroughly to investigate the results of the vocal system pursued in Germany, as compared with the modes of instruction adopted in the New York and other American institutions, which are generally those of the provincial schools of this country. It had been asserted officially, that the institutions for the deaf and dumb in Prussia, Saxony, and Holland were decidedly superior to those of America; that the German instructors possessed the art of teaching their deaf and dumb pupils to speak substantially in all cases as other men speak, and thus restoring them to society. And these assertions were put forth with that apparent novelty which implied that the American teachers of the deaf and dumb were wrapped up in comfortable ignorance of a controversy at all times interesting, but which at the time had been all but unanimously decided in England and America, as well as in most of the other countries where the education of the deaf and dumb had made any progress.

The New York board of directors, therefore, availed themselves of a visit to Germany of the Rev. George E. Day, to set this vexed question at rest. No man could have been better qualified for such a mission. He had been for some years a teacher in the New York Institution, and he was familiar with both the theory and the practice of deaf-mute instruction. He possessed a competent knowledge of the French and German languages; and his object in going into Germany was the prosecution of literary and theological studies. He had also powers of discrimination and philosophical habits, which would render his examination of the subject thorough and his conclusions accurate.

Mr. Day received from Mr. Peet, the principal of the institution, a letter of instructions, in which he was appointed the delegate of the board to the schools for the deaf and dumb in Europe, while his attention was to be specifically directed to those in the German states. He is reminded that the system of instruction adopted in America is that technically known as the French system of De l'Epée and Sicard, as distinguished from that of Heinicke and Braidwood; that its chief characteristic is the employment of an expanded and improved language of gestures as the *principal means*, while the acquisition of written language is the *end* of instruction; that the system of Heinicke is that which differs from it most obviously: and he is directed to state in describing the systems of different institutions, what are the *ends* proposed, the *method* in which the difficulties of language are presented, the *processes* employed, and the *instruments* of communication between teachers and pupils. As to the specific object of his mission, Mr. Day was to ascertain in what schools for the deaf and dumb in Europe articulation was taught, either as a general acquisition or restricted to a class; if taught in a class, whether to those partially deaf, or to those who had learned to speak before losing their hearing; the extent to which pantomime is used in articulating schools; whether lessons given by the teacher who employs gesticulation would be equally intelligible without it, the words being merely read on the lips; if the colloquial intercourse of pupils of articulating schools in their hours of recreation is more frequently carried on by gestures or by the voice and reading on the lips; if the deaf and dumb seem to take pleasure in exercising the faculty of speech; if complete success was attained in all cases in any institution; the proportion of success and of failure, distinguishing such proportion in those who had been deaf from birth; if the articulation of deaf-mutes who had left school some years was easy and agreeable to strangers, or whether they had discontinued the practice of speaking; to what extent reading on the lips is practicable, and the assistance these acquisitions give to pupils in their future studies; the effect of articulation on the health and physical development of deaf and dumb children; and finally, Mr. Day was instructed to inquire in what language articulation and reading on the lips have been found most ready for the deaf and dumb, and in what the most difficult; whether such difficulties arise from the number of silent letters, the various sounds given to the same letter, irregularities of orthography, capriciousness of accent, &c. &c., and how the English language will compare in these respects with the German, French, and other European languages.

The above is a mere skeleton of Mr. Peet's letter. In the condensation which we propose to give of Mr. Day's able and copious report, we must be proportionately brief, confining ourselves almost exclusively to the subject of articulation and reading on the lips.

Mr. Day arrived in England, according to his own statement, at the time of the Midsummer vacation. He visited several of the English schools, but does not mention which of them, and then passed over to Paris, as a centre of information respecting the European schools. We gather from the following passage that he visited the London Asylum: "Even in the London Institution, where articulation is professedly taught, the principal assured me that the object in view is by no means to teach all the scholars to speak, but only to understand by the motion of the lips what is said by others. According to a very intelligent gentleman who had been ten years connected with that institution, not one-fourth can be taught to speak. That such should have been the history of articulation as a branch of instruction in Great Britain, will not appear singular to those to whom the great and peculiar obstacles to be encountered in teaching the pronunciation of our language are familiar."

Instruction in articulation had been recently introduced in the school at Paris to a limited extent,—namely, to those who retained some degree of hearing, who had learned to talk previous to their deafness, or who were otherwise promising candidates. "Of the 115 male pupils, a class of 29 receive instruction in articulation an hour a day. These are divided into two sections, the elder of which have been under instruction not far from a year. The younger division of 15 had so far failed to encourage expectation of their future progress, that the attempt with eight of them was about to be abandoned." Their instructor remarked, that all that could be then said was, that the most promising might be able at least to make themselves understood; that this kind of instruction was peculiarly laborious; that the French as well as the English language, on account of its irregular orthography in respect to pronunciation, interposed great obstacles in the way of success. In a few other schools in France,—those of Bordeaux, Toulouse, and Nancy,—instruction in articulation is given to those who it is supposed can profit from it.

Mr. Day found several German theories of instruction, in all of which prominence was given to articulation as a principal auxiliary. "First is the *Saxon school*, the oldest in Germany, the one whose principles and processes agree most nearly with those of Heinicke. Of this class of instructors, now very small, Mr. Reich, of Leipzig, may be considered as standing at the head. Next in age comes what may be called the *Wurtemburg school*, of which the Rev. Mr. Jager, for many years principal of the Royal Institution at Gmünd, may be regarded as the founder. The teachers, who fully embrace his views, are principally to be found in Southern Germany. Thirdly must be reckoned what may be termed the *New Prussian school*, from the recognised expounder of its principles, Mr. Moritz Hill, the intelligent instructor in the Teachers' Seminary at Weissenfels, in the Prussian province of Saxony. A number of young men embrace his views with ardour, and are carrying them out with zeal.

In respect to the main *object* to be secured by the education of the deaf and dumb, the larger portion of the German instructors perfectly agree. Some, indeed, attach so much importance to the teaching of articulation, as to leave the impression that they recognise no higher aim; but those who take a wider view, regard a preparation for intercourse with society as only a part of the object, and justly remark, with the excellent Mr. Jager, that the main end of the instruction of the deaf and dumb is to prepare them for this world and the next, for life and for death. The *means* are instruction in the ordinary branches taught in the common schools of the country, under such modifications as are considered most suitable for persons in their condition. The *instruments* are, present objects, models, pictures, pantomimic signs, articulation, reading on the lips, and writing. In respect, however, to the relation which these instruments bear to each other, the different teachers widely differ. "Artificial and arbitrary signs, as also the finger-alphabet, the German teachers agree in theory in rejecting, on the double ground that they are not understood among those with whom the deaf-mute is to associate in after-life, and that they hinder the progress of the pupil. There are now only two or three schools in Germany, so far as I know, in which the manual alphabet is at present employed. These justify its use on the ground that words given to the deaf-mute for the first time orally, are not certain to be understood, and that the manual alphabet is a convenient means of supplying the defect."

In the following descriptions Mr. Hill's course has been generally preferred, as being on the whole as successful as any. In order to be a successful teacher of articulation, according to the German measure of success, it is necessary to have, *first*, well-formed organs of speech, and a correct pronunciation; *secondly*, an accurate knowledge of the vocal organs, and of their positions and motions in the production of different sounds; *thirdly*, skill in making the deaf-mute perceive the different motions of the mouth, and teaching him to imitate them himself; and finally, infinite patience. In order to make the pupil acquainted with the position of the organs necessary for the production of the sounds required, the teacher places his own organs in the necessary position, makes the scholar by sight and feeling notice these positions; encourages him to do the same himself; helps him when he does not succeed; and finally, proceeds from simple to composite sounds; that is, to syllables and words, and from these to sentences. As *apparatus*, a looking-glass, in which the pupil may view the position of his own mouth, as compared with that of the teacher, and a paper-folder used to direct the motions of the pupil's tongue, are generally employed. The process of instruction is exceedingly slow, and requires that only one scholar be taught at a time. In Germany, both in the schools for hearing children, and the deaf and dumb, the powers of the letters of the alphabet are taught instead of the name-sounds. For deaf-mutes, indeed, no other course would be practicable.

The best *order* in which to teach the alphabet varies somewhat with different pupils, and hence it is the practice of the best teachers, as early as possible, to try all the sounds of the alphabet, in order both to test the pupil's capacity and ascertain to what points attention must be specially directed. Generally, however, experience has shown the following order to be as successful as any, namely, *h; a* (*ah*), *u* (*oo*), *i* (*ee*), *p, t, k,* or *b, d, g; o, e* (*a* in fate)*; au* (*ou*), *ai* (*i* in lion); *f, s, ch* (the last a peculiar sound); *w* (nearly *v*), *f, j* (*y*); *ä* (or *æ*); *b, d, g,* or *p, t, k; sch* (*sh*); *m, n, ng; l; r; ö; ü* (the two last have peculiar sounds). Next follow the consonants placed *after* the vowels, and the forming of significant words, as *af, of, ruf, ohr*, &c. The main object here is rather mechanical readiness in speaking than acquaintance with the meaning of words.

Mr. Day comments on the patience required, the mistakes into which pupils fall from the want of ear to guide them in pitch and intonation, the high sounds amounting to a scream, the low ones little better than a growl, while others are extremely nasal, which all require time and labour to remedy even imperfectly. He also gives instances of the errors of pronunciation into which the pupils continually fall, and the endeavour to rectify them, and he concludes this portion of his report by saying that "this process is correctly called by the German writers *mechanical speaking;* that much time must necessarily be devoted to it, and that with the greatest efforts, only a defective utterance can be reasonably expected, even under the labours of the most experienced instructors."

Reading on the lips is carried on at the same time with articulation, its difficulties are confessed by the German teachers to be peculiar and great. The object of articulation is to enable the deaf-mute to express his own ideas *to* others, while this is to teach him what is said *by* others, by watching the motions of their lips. How formidable the attempt will appear from considering the following circumstances, mentioned by the German teachers themselves: 1. Many sounds demand positions of the organs so entirely similar to each other, as it respects external observation, that only a *very* practised eye can discover the difference. 2. No peculiar opening of the lips is necessary in the pronunciation of most of the consonants. In such cases it is usually decided by the vowel immediately preceding, and as the lips then conceal, for the most part, the interior of the mouth, the scholar must hence, in respect to many consonants, remain in uncertainty. 3. In the flow of discourse, sounds run so much into one another that only a practised eye can seize hold of the individual parts. 4. The pronunciation of different persons has to the eye so many variations, as sorely to puzzle the deaf and dumb. 5. In connected discourse, many sounds which properly belong to words are lost, which greatly increases the difficulty of understanding by means of sight. For instance, in the sentence *this singer ran nineteen miles*, few persons pronounce so distinctly as to make the *s, r,* and *n* twice perceptible, even to the ear, much less to the eye. So great are these difficulties, both singly and in combination, that it is not pretended that deaf-mutes ever become able in ordinary discourse, to make out each word, or even the greater number. All they do is, to make out a few words and guess at the remainder.

In learning to utter sounds himself, the deaf-mute has the aid of two senses, sight and feeling; in learning to read on the lips however, he must trust exclusively to his eye. Hence the need of special exercises in this department. The following are the most noticeable things in the course: 1. At first the teacher speaks as slowly as possible, opens his mouth wide, and distinctly utters every sound. The consequence is, that the pronunciation of many teachers to their scholars is very unnatural, and such as is *never* heard in general society. This probably is one reason of the unnaturalness observable in the pronunciation of the educated deaf-mutes. 2. The most experienced teachers divide the sentences they utter into small groups of words, with pauses between them; sometimes this division goes so far as the making of a pause after every word, or even syllable. 3. Occasion is taken as often as possible, to make speaking a medium of communication. 4. The pupil is generally required to repeat after the teacher, either silently or aloud. 5. Where the pupil fails to catch the word, it is either written in the air or on a slate to aid him. A few teachers use the manual alphabet for this purpose.

With regard to the results obtained in respect to articulation, Mr. Day's report is full and comprehensive, but by no means encouraging. We include a few extracts in his own words: "As would naturally be expected, the teachers are able to make out what their pupils articulate better than any one else. They are acquainted with the particular mistakes of each, and attach a signification to what appear to others only as incoherent sounds." A passage being selected from the Bible, containing no difficult words, but not in the ordinary school exercises, "one of the best scholars who had been five years under instruction, read it twice over, but the teacher was unable to make out any part of it; on the second reading of another passage by a scholar six years under instruction, the teacher repeated the whole." Experiments of this nature were made at other schools, and led to the conclusion, "that the instructors understand their pupils not so much in virtue of the intelligibility of their articulation, as by being accustomed to the circle of words they commonly use." This view is confirmed by the fact which the teachers acknowledge, "that they do not understand the pupils of other schools so well as their own."

A general impression prevails among intelligent Germans that the articulation of the educated deaf and dumb is unintelligible. A bookseller in one of the cities said, "when the deaf and dumb were taught the manual alphabet, it was easy to converse with them, but since that has been abandoned, and we have nothing but articulation, conversation has become very difficult." Mr. Day comes to the three following conclusions on the *intelligibility* of the articulation: 1. A foreigner would find no difficulty in understanding the more common forms of salutation, and a few simple questions and answers. After a few months instruction the pupils are able to say *guten morgen* (good morning) and the like, in a way to be understood. 2. In hearing the oldest class read, he would be able by looking on the book, in the majority of cases, to keep his eye on the place. 3. In hearing the same class read a passage, the book not being in his hand, or should they attempt to speak anything out of the usual course, he would only recognise a few of the more common words.

The *fluency* attained in reading and speaking is in general very little; the articulation is slow and laborious. The reading resembles that of a young child spelling out his words. With regard to *correctness*, words are pronounced in three or four different ways, from failure of memory of the position of the organs, or from want of sufficient power over the organs; the following are given as examples of mistakes in pronunciation: *hehe*, for gegen; *Jedu*, for Jesus; *spree*, for sprach; *nieband*, for niemand; *frast*, for fragest; *steht*, for stadt; *sapach*, for sprach; *Teibe*, for Weide; *pedete*, for sedete; *Seide*, for Seine; *tint*, for ging. "Of those whose articulation is better than has been described, everywhere constituting exceptions, and everywhere also naturally made prominent when strangers are present, *a large part learned to talk more or less before they became deaf*. Even in cases where the power of hearing is lost at two or three years of age, an idea of articulate sounds is gained, and a flexibility of the vocal organs possessed, which gives a certain advantage in subsequent instruction. But when the child made use of language till four or five years of age, or as sometimes happens, to seven, eight, or even ten, and stranger still, never lost the use of it, the case is a very wide remove from that of ordinary deaf-mutes, and cannot properly be cited without an explanation of the circumstances. It is very common in Germany to refer to a (so-called) deaf-mute instructor in the school at Berlin, named Habermaas, in proof of the degree to which the deaf and dumb can be taught to articulate. That he stood very far above even the best-instructed deaf-mutes, would be sufficiently evident from the frequency with which his ability to converse is referred to. At the same time it alters the case entirely, to learn that not only was he not born deaf, but that he actually lost his hearing at so late a period, that when he entered the school at Berlin, he was still able to talk. In other words, *he had never lost the use of speech*, and as the director of the Berlin Institution, who communicated these facts to me, observed, cannot properly be referred to as an instance of the success of instruction in articulation. 'It is precisely in this manner,' he continued, 'that erroneous ideas are circulated, and unfounded expectations so often cherished, in respect to what can be done for deaf-mutes.'"

There is another class who must be regarded as exceptions in respect to the general results of instruction in articulation, which consists of those who still retain a sufficient degree of hearing, to be made to a considerable extent available. The German teachers acknowledge that the power of distinguishing sounds is of great advantage; although the pupils, by the sense of hearing, may be unable to learn to talk, it insensibly makes the intonation more natural and pleasant, besides affording important assistance in teaching individual sounds.

The results of instruction in reading on the lips was made a separate inquiry. Mr. Day found that pantomimic signs were made use of by the teachers in this branch to a far greater degree than might be expected from the theories they advocate; in conversation even with their most advanced pupils, "they employ a large number of signs for individual words, and not merely substantives and verbs, but even adverbs, prepositions, and conjunctions. . . . . About one-third of the most advanced class, with the aid of the signs employed by the teacher, and the frequent repetition made use of, appear to understand the most of what the instructor says; another third appear to lose a considerable part, while the remainder only seize the most common words, and are obviously much of the time at a loss as to what is going on."

No deaf-mute in Germany would be able to take part in the miscellaneous conversation of a social circle. One of the German teachers informed Mr. Day that on becoming associated with Habermaas as an instructor at Berlin, he early took occasion to say, "You speak too fast, in order for me to understand you; you must speak slowly, and endeavour to make the form of the letters as much as possible on your lips." Partly from the too great rapidity, and partly from the distance also, it would be impossible for a deaf-mute to understand a public speaker. Even Habermaas was unable to understand what was said from the pulpit. The power of reading on the lips, although of course very limited, is available to those who possess it under the following circumstances: First, there must be a sufficient degree of *light*. One of the German teachers apologised for the mistakes made by a pupil by observing that it was twilight, and she could not readily see the motions of the lips. Secondly, it is generally necessary for the deaf-mute to have a full view of the mouth of the person speaking. In some cases, pupils succeed in reading from the lips of the teacher with only a side view. Thirdly, the deaf-mute must be *near* the person speaking; some can read on the lips of their own teachers at the distance of ten and even fifteen feet; usually, however, five feet may be considered the maximum, and many are obliged to be as near as two or three feet. Some teachers are accustomed to make such contortions of the face, in exhibiting the tongue, teeth, and lips, as to render it unpleasant to look at them; others, on the contrary, affirm that these unnatural motions of the mouth are unnecessary, and appear to succeed as well in making themselves understood as the former.

With regard to the influence of articulation on health no statistics had been collected; some teachers contented themselves with observing that they could not say they had seen any injurious consequences, while others admitted that if, in some cases, it had a tendency to strengthen, in others it had a tendency to irritate the lungs, and that no argument in favour of articulation could be drawn from its sanitary effects. Frequently, in witnessing the intense, often amounting to nearly spasmodic, efforts, made by deaf and dumb children in producing vocal sounds, I have felt sure that no parent or physician would be willing to have the lungs of a child or patient, suspected of being inclined to disease, exposed to such a trial. Even the advocates for articulation have their apprehensions, and thus express themselves: "At the outset, caution must be exercised not to cultivate readiness in speaking, at the expense of the health and life of the pupils. . . . . When instruction in articulation is commenced at a later period (than three or four years of age) *great prudence* is necessary that the organs unexercised, and therefore weak, be not too much strained." Of the 92 actual or dismissed pupils in four schools, who are known to have died, 39 perished of consumption. Of the 20 deceased pupils of the Leipzig institution up to 1838, 17 were reported as having died of diseases of the lungs. The distinguished and amiable deaf-mute teacher at Leipzig, Karl Wilhelm Teuscher, who during the fifteen years of his connection with the institution was regarded with pride as a testimony of what could be done for the deaf and dumb, died, it could not be concealed, in consequence of a lung disease, induced chiefly by exertions in instructing his pupils to speak. Was such a fact ever recorded of a teacher who could hear?

Mr. Day selected a number of cases of young men who were engaged in business, in order to ascertain the extent to which articulation was useful to them in the ordinary affairs of life. The first, a compositor in a printing-office, who had been one of the head scholars, could be communicated with *vivâ voce*, in simple words and phrases, but the foreman and journeymen would never think of holding a long conversation with him as with other men; a cabinet-maker who had left the school four years was similarly reported of; a silversmith was a somewhat better example, but he made unpleasant distortions in speaking; another boy, who was met in the street, was conversing with his fellow-apprentice by signs, *not by the voice*; an older sister of the last, was reported of as deriving very little advantage from her articulation; and in the family of these two, conversation was carried on by pantomimic signs. A young man who had been ten years at school could not understand his employer nor the head clerk, nor could they understand him except by writing; and these were the usual reports in all the cases examined. An eminent clergyman observed, "What is truly valuable in the instruction of our deaf and dumb, is the ability to *read* and *write* they acquire. Their ability to speak and read on the lips is trifling, and of very little value."

The only point remaining to be mentioned refers to the comparative difficulties the German and English languages present in the teaching of articulation. It is demonstrable that less favourable results would arise in our language than in some others. The German, the Italian, and the Spanish, are all favourable, being pronounced with slight exceptions as they are written. In languages on the contrary, such as the English and the French, in which the connection between the orthography and the pronunciation is irregular and varying, less assistance of this kind can be derived. In English, many of the letters have so many different sounds, and many too are so silent, that the written word would be a source of perplexity in its pronunciation, which is not the case in the German language. Mr. Day's conclusion is given as follows: *as a regular part of a system of public education, its introduction into our institutions I am persuaded would be a serious misfortune to the cause of deaf and dumb instruction.* The schools visited by Mr. Day were those of Richen and Zurich, in Switzerland; Tübingen and Gmünd, in Würtemberg; Pforzheim, in Baden; Frankfort on the Maine, Bremen, and Hamburg; Cologne, Münster, Halberstadt, Halle, Weissenfels, Erfurt, and Berlin, in Prussia; Leipsig and Dresden, in Saxony; Weimar and Eisenach, in Weimar; and that of Brunswick. There are several particulars in Mr. Day's report which have not been touched upon here, such as the general knowledge and acquirements of the German pupils compared with others, their religious training, the great expense attending the articulation course of instruction, from the greater number of instructors required, the loss of time involved in a mechanical acquisition, and consequently the less progress made by the pupils in any definite time. All these are subjects which should enter into the consideration of those whose province it is to conduct or direct the education of the deaf and dumb.

The period prescribed for instruction in the public institutions for the deaf and dumb varies in different countries; in few cases is it so short as in England: in nearly all the Continental institutions of celebrity it is considerably longer. With us only five years in most instances are allowed for the education of pupils, who are wholly or partially sustained by the funds contributed for their support. Throughout France, Switzerland, Würtemberg, Sweden, and Poland, the pupils are permitted to continue six years. At the institution of Groningen, at those of Copenhagen and Sleswig, the pupils remain seven or eight years; at Vienna from six to eight years; at Berlin they continue from six to nine years; and at Leipzig for a like period. Should no other modification of the institutions of Great Britain take place with regard to the duration of a pupil's continuance in them, it would be well if some provision were made to enable pupils of superior talent, and those intended for the more liberal arts and trades, to continue under special instruction, to qualify them for their future business, for a longer period than those who need no such preparation. Nearly every boy may learn to make shoes, to hew wood, and to draw water; but it requires a peculiar training to form artists, engravers, clerks, carvers, modellers, and superior mechanics—arts in which there is nothing to prevent the deaf and dumb from excelling.

The subjects on which instruction is imparted must necessarily vary with the length of time given to education. The following plan of a course of instruction cannot be satisfactorily accomplished in less than six years; it is, however, an approximation to what is attempted in some of the British institutions. Still, it must be clear to every one that the educational results attainable in a limited number of years must depend greatly on the age of a pupil at admission. A term of six years, from eight to fourteen, would produce very inferior results to a term from ten to sixteen years of age. We have already noticed the instruments of teaching, and shall proceed to mention the matter of instruction and its division with regard to time, which is assumed to be pretty nearly what is actually accomplished. With regard to a sixth year, were our institutions so modified as to enable the pupils to be kept for such additional time, it would generally be devoted to confirming the pupils in their previous acquirements, to a repetition of subjects of more than common interest, and to special instruction, according to the dispositions and endowments of the pupils, connected with their future destination. In short, it should in every way be made a retrospective year as regards their school acquirements, and prospective as to their future interests.

The subjects for instruction are:—

Language, including nomenclature and syntax.
Writing, as an acquirement and a means towards higher attainments.
Reading, by dactylology and by the eye.
Religion and morals, preceptal and applied.
Geometry and mechanical drawing.
Geography, physical and political.
Arithmetic, elementary and applied.
Drawing, as an art and in connection with design.
History, ancient (from the Old Testament).
History, modern (of England especially, and exemplary biography).
History, natural (animal, vegetable, and mineral kingdoms).
Physics (properties of natural bodies, astronomy, mechanics, chemistry, &c).
Composition (to induce the ready use and application of language).

The *First Year* would be generally devoted to instruction in language by means of natural signs, dactylology, and writing. Instruction in numbers and their combinations by sensible objects, by manual notation [DACTYLOLOGY], by figures, and by words. Occasional instruction in moral and religious duties by signs.

Second Year.—Instruction in language, continued by the same instruments as in the former year; in arithmetic. Geography commenced with ground-plans of school-room, house, and neighbouring grounds, streets, roads, fields, &c. Lessons on form, introductory to geometry. Moral and religious duties. Composition, commenced by pupils writing down their own observations on facts and occurrences in short sentences. Drawing commenced.

Third Year.—Language continued; the two former years are chiefly given to nomenclature; syntax will now more especially demand attention. Lessons continued in geometry, geography, arithmetic, physics, and composition. Scripture history and drawing continued.

Fourth Year.—Language continued, and especially applied to composition. Direct instruction continued on all the subjects named for the preceding year.

Fifth Year.—In addition to bringing the branches of knowledge commenced to a close, abstract ideas and figurative language; doctrinal religion; the physiology of the human body; the moral and social duties of man, his dispositions and faculties, should be brought under consideration during this year, and continued for as long a period as the pupil remains under instruction. Most of the new subjects here mentioned would necessarily be the work of a sixth year. Those parents who can afford to continue their children as private pupils might have them instructed in every department of a sound English education, and, if they thought proper, qualified for the more liberal arts and professions; for there exists no insurmountable barrier to the acquisition of classical learning, mathematical and scientific attainments, and a knowledge of the modern languages.

After the explanations into which we have entered on the modes and subjects of instruction, no lengthened remarks on the processes seem to be requisite. In teaching substantives the object is pointed out, and the name is written, spelled on the fingers, articulated, or signed, as the medium of communication may be; all these are so many modes for expressing the object referred to. Thus if *man* be the object, it is pointed to, or the word *man* is presented before the eyes of the pupils, or it is spelled by means of the manual alphabet, or it is pronounced, or the beard is touched, and the height of man is indicated. In the same manner other names of objects are conveyed to the pupils, who soon see that a connection exists between *our* conventional signs and objects, as well as between *their* conventional signs and objects. Adjectives are taught in a somewhat similar way; the colours are as easy as any other qualities to introduce pupils to this class of words. A few wafers, all of the same size but of different colours, are good mechanical aids. When the colours are known the teacher will pass on to other adjectives. The nature of the indefinite article is easily exhibited; the definite can only be acquired by practice, in the manner of hearing and speaking children. Verbs of action are easily imitated by signs, and the pupils are prepared to expect that there are words to indicate *action*, as well as *objects*, *number*, and *qualities*. Adverbs, which indicate the manner of an action, naturally follow verbs; to *run quickly*, to *walk quickly*, to *walk slowly*, may, it will be seen, be accurately conveyed by the means employed to bring instruction so immediately under the cognizance of the senses. The possessive, demonstrative, and personal pronouns are exemplified by real facts which come under the observation of the pupil, or which are purposely contrived to arrest his attention. Many of the prepositions and conjunctions can be rendered sensible and intuitive; other particles are taught by diagrams, and by examples produced as occasion requires, and reproduced by the pupils from instances supplied by themselves. The moods and tenses of verbs, and the auxiliary verbs, can only be taught effectually by the events and casualties which bring them into use in ordinary life; these are constantly occurring, and it is the business of the teacher to turn them to account for the improvement of his pupils. Abstract ideas must be traced downwards to those simple ideas from which they originate, as well as from the simple idea upwards; indeed the constant application of analysis or induction, which is continually called forth in conveying instruction as far as may be through a sensible vehicle, renders this office of language more easy than can be conceived by those not accustomed to employ such powerful instruments in the process of education. Figurative expressions, comparisons, similes, metaphors, require a series of progressive lessons, in which language should be employed to illustrate each step from the easiest to the most complicated figures of speech. Examples might be taken from the Scriptures, from fables, allegories, and parables; they should be especially written with a view to utility, and adapted for the explanation of such subjects as occur in any course of education. Though in the plan marked down we have given two years to *nomenclature*, and have not recommended the commencement of *syntax* till the third year, it is not intended that this shall interfere with the pupil's gradual introduction to small sentences expressive of sensible ideas. Indeed the progress in language of a deaf and dumb pupil, to be successful, must be assimilated as nearly as possible to the progress of other children, and he must be continually accustomed to those ordinary exemplifications of language, affirmative, negative, and interrogative, which other children use, and which advance in complexity as their years increase and their minds become enlightened. As the manner and substance of a child's conversations indicate the society in which he has been brought up, and the educational advantages he has received, so will the ordinary remarks and compositions of the deaf and dumb exhibit the benefits they have derived from the means employed to bring them into communion with society, and to elevate their thoughts and understandings to the level of those who labour under no such deprivations.

The art of instructing the deaf and dumb has not been always free from empiricism. Several attempts, some trifling, others heinous, have been made to claim for them intellectual powers and literary attainments to which they have not been entitled; these attempts have for a time been successful, the public has been deceived, and the re-action has been injurious both to the deaf and dumb and their teachers. We trust the days for such deceptions have passed away, and that we live in purer times. Whether the celebrated answers of Massieu, the pupil of Sicard, must be considered as more than liable to imputation, is too difficult a question to decide now. They are so apposite and beautiful that we harbour suspicion with regret. There is no doubt but Massieu possessed powers of mind amounting to genius, but even allowing this, there are few of the instructors of the deaf and dumb of the present day who believe his brilliant definitions and exemplifications to be the genuine productions of his own mind; they know that time has been when, emulating the fame of Massieu, definitions as poetical, compact, and expressive, have been *taught to pupils*; that they have been fully explained, fixed in the mind and memory, and reproduced when required; but they also know that these were not the ideas of the pupils themselves, but of their instructors, though the pupils have had the credit of them. Let us explain how such effects can be produced. The word *eternity* occurs in Massieu's lesson with Sicard. The master illustrates the meaning by drawing a line, and represents it as prolonged at both ends indefinitely; he speaks of this line as representing time past, of which there was no beginning, and time future, of which there shall be no end. Hence, when Massieu gives his answer or definition of eternity, he merely writes, as a less able class-mate might do, "A line which had no beginning and shall have no end," putting the illustration into language, with such others as he had been taught, as, "A day without a yesterday or to-morrow." Analogous was his answer to the question on *time*, "A line that has two ends—a path that begins in the cradle and ends in the grave." The same explanation may be given of the answers on *gratitude*, "the memory of the heart;" a *sense*, "an idea carrier," &c. But the best evidence that teachers have of the process followed is in their own experience. One of them has written thus, "Most of these answers are highly figurative. But the deaf and dumb generally avoid figurative language; their compositions usually are eminently literal; they readily detect resemblances, and frequently employ comparison, but they very rarely personify." The writer of this article has taught 500 deaf and dumb pupils during the last 30 years; but instead of being able to testify, as some writers have put forth, that the deaf and dumb have "a natural aptitude for defining abstract terms," his experience has shown him the reverse. Some of his pupils have gone through a series of abstract nouns in their school-course, but though they have attained a certain amount of skill in defining, illustrating, or exemplifying such words, it was only achieved by dint of severe mental application, by no means common in young people. In his after life Massieu exhibited none of that talent which made his name, with that of Sicard, so famous, although opportunities were not wanting. He conducted an establishment for the deaf and dumb at Lisle for many years, with but little success. He published a nomenclature for the use of the deaf and dumb, of which Degérando says, "It has the double vice of being exuberant; by its multiplicity of words useless to the deaf and dumb, and of being destitute of all logical arrangement;" and he adds that Massieu "could never write the French language with accuracy." He died at Lisle, in 1846.

The most exaggerated notions prevail as to what may be accomplished for the deaf and dumb, in the limited time usually allotted to their education. What is actually done for them in many of our institutions is, however, sufficiently marvellous. Nature does not act so bountifully towards them as is commonly believed, making amends for the lost sense by greatly increased power in the remaining ones, and it is but a popular mistake that the deaf and dumb experience this quickening influence. They are, however, made happy under instruction; they have fellows with whom they can hold converse; they acquire habits of study, care, and industry, which are useful to them in after life; their social, moral, and religious sympathies are awakened; and their minds are informed with knowledge, from which, before the process of instruction commenced, they were shut out. But all this is achieved by the pains-taking labour of the teacher, and he must labour with much patience to ensure that success to which he looks for his reward; for there is no natural gift possessed by these children of silence to ease him of a single burden borne by the ordinary teacher, while he has many doubts and disquietudes which are unknown in the schools for the ordinary population.

DEAF AND DUMB, INSTITUTIONS FOR THE. In 'Le Bienfaiteur,' No. 4 (October, 1853), the Abbé Daras gives a list of 455 establishments, including public institutions, associations, and private schools for the education of the deaf and dumb, with the dates of their foundation. Mr. Day, in his Report (1844), gives a table of 172 institutions in Europe and America, namely: 16 in Great Britain and Ireland; 44 in France; 9 in Italy; 10 in Switzerland; 9 in Austria; 22 in Prussia; 10 in Bavaria; 6 in Würtemberg and Baden; 15 in Saxony, Hanover, and the other German states; 4 in German free cities;

8 in Belgium and Holland; 4 in Denmark, Sweden, and Norway; 2 in Russia and Poland; and 10 in the United States. The actual number of institutions for the deaf and dumb in England, Wales, Scotland, and Ireland, is 20, of each of which we shall give some particulars.

The public establishments for the reception and education of the deaf and dumb of England are situated respectively at London, Birmingham, Manchester, Liverpool, Exeter, Doncaster, Newcastle on Tyne, Bristol, Brighton, and Bath; one for Wales, at Swansea; those of Scotland at Edinburgh, Glasgow, Aberdeen, and Dundee; and those of Ireland at Dublin, Belfast, and Strabane. The asylum at London, situated in the Kent Road, was opened in 1792; it was the first asylum in the kingdom for extending to the indigent deaf and dumb the benefit of education, and, from its establishment to the present time, 2889 pupils have been received and educated there. A bust of the Rev. John Townsend, which is placed in the committee-room, perpetuates his memory as the founder of the institution. Three hundred children from all parts of the kingdom reside in the asylum, which receives ample support from the wealthy; indeed it possesses, besides its annual receipts from subscriptions, donations, and legacies, a funded property of probably not less than 160,000*l.*, by which its permanent income is greatly increased. The instructor of the asylum is the Rev. James W. Watson, a grandson of the late Dr. Watson; he is assisted by male and female teachers. The whole is under the management of a committee. The cost per head of each pupil is under 25*l.* a year; its annual income is little short of 10,000*l.*, more or less, depending in some measure on the amount received each year in legacies; this sum in 1858 was 2150*l.*, the dividends from stock about 5000*l.*, subscriptions 1500*l.*, and from other sources about 1000*l.* was received.

The second institution which came into operation in this kingdom was that of Edinburgh, which was established in 1810, and at first placed under the care of Mr. Braidwood; he was succeeded by Mr. Kinniburgh, since deceased. The number of children at present under instruction is 58. The number of instructors, including the principal, 3, and a sewing mistress. The income is stated by the secretary to be about 700*l.* a-year from subscriptions, and 400*l.* to 500*l.* from payments of pupils. The admission of deaf and dumb children into Donaldson's Hospital has circumscribed the operations of this institution.

The general institution for the deaf and dumb at Edgbaston, near Birmingham, was commenced in 1812. It was formed in consequence of a lecture on the subject which was read by the late Dr. de Lys before the philosophical institution of Birmingham. This gentleman, and Dr. Alexander Blair, late professor of English literature in the university of London, are to be regarded as the first promoters of the institution. It was placed under the superintendence of Mr. Thomas Braidwood, one of the sons of Mr. Braidwood of Hackney. The institution has no provincial limits. It contains 92 pupils; the present master is Mr. Arthur Hopper, who has six assistants. The management of the domestic department is superintended by a matron. For many years this establishment was confined in its means; but its buildings have been recently enlarged, so as to admit of a great increase of pupils, and their sanitary condition has received every improvement that could be introduced. These alterations have involved an outlay exceeding 2000*l.* The funds of the institution arise from subscriptions, donations, legacies, interest of money invested, and payments on behalf of the pupils. Nearly a fourth of the income is derived from annual subscriptions, and more than a fourth from pupils' payments. The cost of each pupil is stated at about 25*l.* annually.

The national institution for the deaf and dumb of Ireland is situated at Claremont, near Dublin. It owes its origin and progress to the strenuous and unwearying exertions of Dr. Charles Orpen. Soon after its commencement in 1816, it was placed under the care of Mr. Joseph Humphreys, who continued to be the principal till 1841, since which time several others have occupied that post. The present master is Mr. E. J. Chidley, formerly an assistant at the London Asylum, Kent Road. About the year 1846, a great change took place in the affairs of the institution. Its original operations included the whole of Ireland; but the extension of that established at Belfast to the entire province of Ulster, deprived the national institution of a certain number of pupils, and of funds derived from that province. The parent institution is now limited in its operations to Leinster, Munster, and Connaught. About the same time a Roman Catholic institution was established in Dublin, which again reduced its number of pupils very considerably. The number reported this year is 56. The accommodation is sufficient for 150 pupils; there are consequently heavy establishment charges, which make the average annual cost for each pupil very high: these, however, are in process of reduction. A few years ago, a deputation from the managing committee visited the principal institutions in the kingdom, with the view of re-modelling their own by introducing such improvements in every department as were found feasible and suited to the altered condition of the establishment.

The Glasgow Institution, formed in 1819, chiefly for the west of Scotland, has had several teachers. Mr. Duncan Anderson, whose persevering efforts have raised it to a high degree of prosperity both as to rank and character, has been its principal for more than thirty years. It contains 82 pupils. It has no fund more permanent than that derived from payments of pupils, donations, legacies and annual subscriptions: the cost per pupil is about 20*l.* annually. Mr. Anderson has four assistants. The domestic arrangements are superintended by the matron. A workmistress has charge of the girls in their sewing and household employments.

The institution at Aberdeen was commenced in 1819; its pupils are chiefly from the north of the Dee, but it has no prescribed limits. About a third of its income arises from subscriptions and donations, a fourth from pupils' payments, and the deficiency is made up from certain funds which are applied to charitable purposes by their trustees. There are 30 pupils, whose cost per annum is about 20*l.* a head.

The school for the deaf and dumb at Manchester was opened in 1823; in 1839 it was removed to a very commodious building, erected by subscription at Old Trafford, on a uniform plan with that for Henshaw's Blind Asylum, the two establishments being in exact architectural correspondence with a chapel between them for the inmates of both and the neighbouring residents. The funds of the institution are derived from subscriptions, about two-thirds; children's payments, one-third. There are 103 pupils whose average cost is 21*l.* each per annum. For the last eighteen years the Manchester Institution has been under the charge of Mr. Patterson, as principal, who is assisted by five junior teachers. In the report of the institution for 1857, the examining committee suggest a novel addition to their institution, namely, an "Infant School," for the reception "at the earliest age practicable of the deaf-mute;" and in the report for 1858, the necessity of extended accommodation for ordinary pupils is urged, and a bazaar proposed as the means of raising the requisite funds for both objects. This bazaar was held in May, 1859, and was so successful that the proposed extensions are now in course of progress. It would perhaps be premature to condemn the project of an infant school for the deaf and dumb, but we must confess we would rather have added a year of gratuitous education to all ordinary pupils whose parents would accept the boon, than have incurred the annual expense of supporting the deaf and dumb at the public charge, probably nine years instead of six.

The Liverpool School owes its origin to Mr. William Comer of that town: it was opened in 1825, and commenced as a day-school, but its original plan has undergone some modifications, and its pupils are of the mixed character of boarders, day-boarders, and day-pupils. Several changes have taken place in its mastership; the present headmaster is Mr. Buxton, formerly an assistant at the London Asylum. This school contains 85 pupils,—33 day-scholars and 52 boarders. Nearly a third of its income is obtained from subscriptions, and rather more than a third from children's payments; the other portion is derived from donations, legacies, and interest of investments. There are three assistant teachers and a sewing mistress.

The West of England Institution for the deaf and dumb was established in 1827. It is situated at Exeter. Its especial object is the "instruction of the deaf and dumb resident in Devon, Cornwall, Dorset, and Somerset." Like the others it is supported by subscriptions, donations, legacies, and by payments on behalf of the children; the payments from pupils amount to about one-third of the expenditure. At present it contains 42 pupils. Its head-master is Dr. Scott, who has three assistants, including the workmistress.

The Yorkshire Institution for the deaf and dumb, situated at Doncaster, was commenced in 1829. Throughout its whole course it has been prosperous. Its funds have gradually increased, and it has been enabled to admit every applicant: and for several years a portion of its income has been set aside towards the establishment of a permanent fund; these accumulations form the capital from which the dividends mentioned below are derived. There are upwards of 100 pupils under instruction, 562 have been received since its establishment. The average cost of each pupil is 20*l.* per annum. The funds are derived from annual subscriptions, about 900*l.*; payments on behalf of pupils, 800*l.*; interest from investments, 150*l.* a year. Donations make up the deficiency. As a rule legacies are funded, but there have been a few exceptions. Mr. Baker, the head-master, has six assistants; the girls, out of school hours, are under the charge of a work-mistress for sewing and domestic work.

The Ulster Institution for the deaf and dumb and blind, situated at Belfast, was first established in 1831; it confines its operations in the collection of funds and the admission of *free* pupils to the province of Ulster; but paying pupils from other districts have occasionally been received. It is sustained by donations, subscriptions, congregational collections, and legacies. In 1858 about 1650*l.* was raised by collecting cards through the medium of district auxiliaries. The entire income exceeds 2000*l.* a year; about 90*l.* was received by pupils' payments in 1858. The ordinary expenses make the cost of each pupil about 18*l.* per annum. The number of deaf and dumb pupils is 94; of blind, 23. The Rev. J. Kinghan is the principal; he has five assistants for the deaf and dumb pupils, and one for the blind. Under the management of the present head-master this institution is assuming a favourable position, and winning from the public a large amount of regard and support.

The Northern Counties Institution for the deaf and dumb, at Newcastle upon Tyne, comprehends the counties of Northumberland, Durham, Cumberland, and Westmoreland, and the town of Berwick upon Tweed. It was established in 1839. It is supported by subscriptions, donations, legacies, and payments from pupils. One-third of its income is derived from subscriptions, and about one half from pupils' payments. The average cost of the pupils during the last five years has been 17*l.* 15*s.* There are 62 pupils in a house calculated for only half that number, but efforts are being made to obtain a suitable and commodious building which promise to be immediately successful; the head-master is Mr. W. Neill, who has three assistant teachers.

The Bristol and Western District Institution for the deaf and dumb was established at Bristol in 1841; its benefits are available to all deaf-mutes residing within the city and county of Bristol, and the adjacent counties of Gloucester, Wilts, Somerset, Hereford, and Monmouth, together with the southern division of the Principality of Wales. Its income from subscriptions and donations is about 400*l.* a year, from children's payments 212*l.*, from Consols 88*l.* The number of pupils is 22. The cost per pupil, with so small a number, and under a heavy rent and other establishment charges, is larger than at the generality of these institutions, being upwards of 30*l.* a year. Mr. Clyne is the head-master, he has a female assistant who is deaf and dumb, and a work-mistress has charge of the sewing and domestic occupations of the girls. The expense of this establishment is likely to undergo a considerable diminution, for in March last (1859) the pupils were removed from their rented premises to a house in Park Street, equal to the accommodation of forty pupils, which has been recently purchased. The domestic arrangements are under the charge of a matron, and a ladies' committee gives its services.

The Brighton Institution for the instruction of deaf and dumb children of Sussex, Hampshire, and Kent, was established in 1841. Pupils are received, however, from all parts, priority of admission being given to those residing in the three counties named. It is sustained by annual subscriptions and donations, and by payments from the children. In 1858 two-thirds of the income was from childrens' payments, and one-third from subscriptions and donations. The number of pupils is 78; their annual cost is stated at the small sum of 16*l.* a head. There are eight teachers, four male and four female; two of the latter superintend the instruction of the girls in needlework and domestic duties. The head-master is Mr. W. Sleight, who has been connected with it from the time the first experiments were made, demonstrating the necessity for and the utility of such an institution.

The Institution for the blind and deaf and dumb in Walcot Parade, Bath, was established in 1843; it has no local limits; it is sustained by contributions, pupils' payments, and an annuity of 20*l.* per annum. The subscriptions amount annually to about 360*l.*, pupils' payments to 520*l.*; the number of pupils is 44, including three partially blind, as well as deaf and dumb, and 12 day and Sunday scholars. A Sunday service is conducted by the Rev. Fountain Elwin, the president, which has been found very acceptable, as well as beneficial to a certain number of adults.

The Dundee Institution for the deaf and dumb and blind, is chiefly limited in its operations to Forfarshire; it was established in 1846. It is sustained by voluntary subscriptions, by payments of the full fees and board by parents of some of the pupils, and by partial payments of parents and parishes for others. The average annual cost per head is 18*l.*; there are 40 pupils, and two teachers. Mr. Alexander Drysdale, himself deaf and dumb, is the principal.

The establishment of a Roman Catholic institution for the deaf and dumb in the vicinity of Dublin, was accomplished in 1846; the department for girls is connected with the convent of St. Mary's, Cabra, and was opened in 1847; the number of girls is 80, they are taught by the sisters of St. Mary's convent. The boy's department is under the care of the Christian Brothers of St. Joseph's, Cabra, of the religious order of Saint Dominick; the number of boys under instruction is 87. The cost of each pupil is about 18*l.* per annum. The institution is under high patronage, and is adequately supported. During the year 1857 its annual subscriptions amounted to 767*l.*; donations, 710*l.*; the pupils' payments were 1262*l.*; and bequests amounted to 156*l.*

The Derry and Raphoe Diocesan School for the deaf and dumb, situated at Strabane, was commenced in 1846. It is limited to these united dioceses, including the whole of the county Donegal, and parts of Tyrone and Londonderry. It is sustained by voluntary subscriptions, without any payments from pupils. The 15 children it contains are maintained and educated at a cost of 13*l.* 9*s.* a-head. There is only one instructor, Mr. G. W. Downing.

The Cambrian Institution for the deaf and dumb was established in 1847. It was commenced at Aberystwyth, but a few years after removed to Swansea, at which place a permanent building has been erected, which has been occupied by the pupils about two years. The institution may, however, still be regarded as in its infancy, having had certain difficulties to surmount, together with changes of masters, which have prevented it from accomplishing all its purposes. It has 17 pupils. Its income in 1857-8 was about 600*l.* Mr. A. Melville, formerly an assistant at the Yorkshire institution, has recently been appointed the master.

Donaldson's Hospital, at Edinburgh, was opened in 1850. It is a richly endowed establishment for the maintenance and education of 150 boys and as many girls, with a preference for all of the name of Donaldson and Marshall. The governors have devoted a portion of the institution for the education and maintenance of deaf and dumb children. There are 42 deaf and dumb boys and 28 girls in this department. The number of instructors occupied in this special work is four, three males and one female. The pupils are admitted between the ages of seven and nine, and remain till they are fourteen. The principal is Mr. Angus McDiarmid. Whether the experiment here in progress, of bringing up deaf-mutes with hearing and speaking children, will prove beneficial in any respect to the former, has yet to be seen. Some hopes were once entertained that results might ensue favourable to the acquisition of our vernacular idioms, always a work of some difficulty to the deaf and dumb.

All these institutions are under the direction of committees chosen from the subscribers residing in or near the towns where they are situated. These committees appoint masters and other officers not chosen at the annual meetings; they establish the general rules of the institutions which they control, but they do not interfere with the course of instruction. One or more examinations of the pupils take place in the course of each year, which the subscribers and the public generally are invited to attend.

Industrial occupations for both boys and girls are a feature in most of these institutions, though trades, as a future means of obtaining a livelihood, are not taught; the limited time which the deaf and dumb have for instruction in language and knowledge forbids the appropriation of any portion of it to what may be better acquired under a master and during apprenticeship. It must be borne in mind that ordinary apprentices have fourteen or fifteen years in which to learn the language, ways, and customs of the world in which they live, while the deaf and dumb have to acquire all this by direct teaching during their school years to enable them to compete with others in the acquisition of a trade; in order to make the most of their school life, long hours of teaching generally prevail, and the industrial employments and other exercises which health demands fill up their days. Large gardens are attached to many of the institutions, in which the boys obtain a certain amount of healthful exercise by their labour; in two of them printing is taught to some of the elder children, basket-making in one, farm-work at another; in all, the girls are taught household work, and sewing; and in many, the boys perform those offices which fall to men-servants in large establishments. Several of the institutions grant premiums towards the apprentice fees of both boys and girls on leaving school, provided the business and the master or mistress are approved of. In most of the institutions there are three classes of pupils; the most numerous are the poor, who are either instructed gratuitously, or who pay a small sum, varying from 2*s.* 6*d.* to 3*s.* 6*d.* per week. These sums are paid by the parents or friends of the children, or by the parishes to which they belong. In the latter case, it has often been found a difficulty to convince overseers of the policy of educating their indigent deaf and dumb, and thus restoring them to society; but under the operation of the new Poor Law, the difficulty is in some measure provided for; permission being there given for the advance of sums for the "deaf and dumb and blind." It must, however, be stated, that this permissive clause is not sufficient to bring the deaf and dumb of the poor and pauper class under instruction, and the sooner the required payments are made compulsory the better it will be for the deaf and dumb and the community. The second class of pupils received into our institutions are those whose parents can afford to pay their expenses, so that no burden is in such cases imposed on the funds subscribed for charitable purposes. The payment is generally 20*l.*; this being about the average expense of pupils in the provincial institutions. The third class of pupils are those whose friends can afford to pay a large sum for their education. The number of such pupils being very limited, the masters of institutions generally have a proportion of the income arising from this source assigned to them.

The establishments for the deaf and dumb have become doubled in number during the last thirty years, and considerably more than double the number of children of this class have come under instruction during the same period. Most of the important institutions are now full, several have been enlarged recently, and others are contemplating further extensions. In one only has the number materially diminished, namely, the National Institution of Dublin, while its decrease is more than made up by the extension of the Ulster Institution, and the Roman Catholic establishment at Cabra. The number of pupils under instruction in the United Kingdom is now 1550, against 780 when the article in the 'Penny Cyclopædia' was published twenty-two years ago. And what are the Results of this extended movement and of the education of this class? We are enabled to answer this question thoroughly with regard to one institution, at which it is the custom at intervals of a few years to make inquiries respecting all former pupils on the following points:—

1. In what occupation has A. B. been engaged since *he* left school?
2. Is it found that *he* has acquired that business with the same facility, or nearly so, as those who hear and speak?
3. Has *his* conduct been generally approved of?
4. Note any particulars respecting A. B. which are likely to be interesting to the committee.

These inquiries were renewed during the present year, they were addressed to clergymen of parishes or other ministers of religion, to employers, and to parents, and from the detailed answers, which are all published, the following analysis has been made. Of the 534 who had been received into the institution, 430 had left school, and are thus accounted for: of 296 (174 boys and 122 girls) there are formal or informal returns; 32 were deficient in intellect though generally improved, 27 died during education, or before acquiring trades, 4 were removed from delicate health, 13 left school, chiefly from removal of parents, during education, 11 were private pupils, who returned to their friends, 47 have made no return to the inquiries instituted; 174 of the 296 were boys, who have been put to the following trades: 32 shoemakers, boot-closers, cordwainers, 28 labourers, or farm servants, 16 tailors, 12 employed in mills, factories and clothing trades, 10 cutlery, and Sheffield trades, 9 joiners, cabinet makers, carvers, turners, French polishers, 8 letter-press printers, or compositors, 8 engravers, or wood-engravers, 7 engineers, mechanics, moulders, pattern makers, 5 farmers, 4 lithographers, or lithographic printers, 4 pattern designers, 4 quarrymen, 3 bookbinders, 3 gardeners, 2 clerks, 2 painters and decorators, 2 bakers, 2 artists, 2 nailmakers, 11 at sundry occupations, as under; namely, 1 assistant at institution, 1 stenciller, 1 hawker, 1 brickmaker, 1 modeller, 1 type-founder, 1 collier, 1 miller, 1 watch-maker, 1 porter, and 1 hairdresser.

The 122 girls have been brought up to the following employments: 44 dressmakers; 31 assist in domestic duties, sewing, &c., at home; 17 servants or laundresses; 14 milliners, dress and bonnet makers; 10 burlers, reelers, winders, weavers; 2 boot and shoe-binders; 4 sundries (tailoress, cap-maker, lacemender), &c. Of the 296 included in the above summary, we have full and satisfactorily attested returns on 217.

The next important object of this inquiry was to ascertain the facility with which the pupils who had been put to trades acquired them, in comparison with young people not deaf and dumb. Of the 132 boys, it is found that 80 acquired their business as well as others, 28 nearly as well as others, 9 more readily than those not deaf and dumb, and 10 not so well as those who hear and speak; 5 cases are doubtful. Of the girls it is ascertained that 55 acquired their business as well as others, 21 nearly as well, 5 more readily than others, 3 not so well, 1 case doubtful. The summary of the whole 217 will stand as under: 135 acquired their business as well as others, 49 nearly as well, 14 more readily than young people generally, 13 not so well as those who hear and speak, 6 doubtful cases.

A conclusion very favourable to the pupils may therefore be formed; they are, to say the least, equal to young people endowed with all their faculties; for if only 13 out of 217 failed to a certain extent in acquiring their business, it may be fairly inferred that an equal number of failures would have occurred out of 217 persons with all the advantages of speech and hearing; and it must be borne in mind that in nearly all cases these children were under the disadvantage (referred to by some of their employers) of associating with parties not accustomed to the deaf and dumb, who found it difficult to explain their precise meaning, or give directions with accuracy. On the other hand, several of the employers are so thoroughly satisfied, that they express their willingness to take other pupils from the institution. Enough has been ascertained with regard to the facility of the pupils in acquiring trades to force this conclusion on the public mind, namely,

That the deaf and dumb, as a body, acquire trades quite as well as those who hear and speak.

The part of the inquiry on which the greatest anxiety has been felt regarded the character and conduct of the pupils after quitting the institution. A deaf and dumb young person attracts attention which others do not; and while one party by over-indulgence would manifest unusual and uncalled-for kindness towards such a person when thrown on the world, another would heartlessly lead him astray, by indulging him in propensities which require to be checked.

On this point, knowing there is a liability to error, it may be observed that a deaf and dumb apprentice ought to be treated precisely like ordinary apprentices; in his business he should be *shown* what others are *told* of operations and their effects, and this *showing* will generally repay the little extra trouble required, in the accuracy of its results, compared with *telling* in ordinary cases. He should neither be treated more harshly nor more indulgently than others, and his general treatment should manifest to him that he is considered morally and mentally responsible in the same sense as others.

With reference to the reports received as to the conduct and character of the boys: 98 are reported of favourably, 18 very favourably, 6 have given cause of complaint, 3 have misconducted themselves, and in 7 cases the reports are doubtful. Of the girls: 55 are reported of favourably, 21 very favourably, 6 have given cause of complaint, 3 have misconducted themselves. So that the summary of the 217 will appear thus: 153 are reported of favourably, 39 very favourably, 12 have given occasional cause for complaint, 6 have behaved very ill, 7 doubtful.

It is matter for congratulation, that out of 217 cases there are only *six* of immoral conduct, while the large proportion are well reported of. Of the slight causes of complaint, several of them are cases of *obstinacy*, but the question may arise whether the same proportion would not have occurred in ordinary cases—whether out of 217 apprentices, from any class, *so many* would have been reported of favourably, and *so few* unfavourably?

Although the above statement refers to only one institution, there is every reason to believe that reports equally favourable might be obtained from many others; as the result of a direct inquiry made at all the institutions on this point, it may be inferred that all the pupils, with the exception of about 5 or 6 per cent., conduct themselves creditably in after life. Such results show the public that their expenditure in support of institutions for the deaf and dumb is well repaid and lead to the question why those of general education are less satisfactory. The system of boarding the children must be credited with a certain measure of these favourable effects; the children are separated from the evil influences of towns, and placed under the charge of chosen assistants, who superintend them both in and out of school for five or six years, and during this time habits of regularity, propriety, industry, and attention to moral and social duties are formed, which must assist materially in influencing their future lives. With children not labouring under their privation, a similar system would doubtless be productive of equally good results; and as less time would be required in school, the industrial element might be added, and time applied to productive arts which would reduce the cost of education to such an amount as a small tradesman or a skilled mechanic might pay without inconvenience.

Although the instruction and education of the deaf and dumb have become more general, by the extension of the older, and the establishment of new institutions, there is some doubt whether the quality of the instruction has materially improved. Thirty years ago, a danger was felt that much of the practical application of the art would be lost, for no means had been taken to give permanence to any series of lessons by means of the press. The different teachers experimented, and carried out what seemed right in their own eyes; they had the theories of those who had lived before them, but no series of lessons reduced to order, and no aids for those who were inclined to take up the work as a profession. In the year 1841 two of the teachers resolved to print their early lessons, not only for the use of their own pupils, but also to give form and substance to their manuscripts, and to establish a beaten track which others might widen and improve, and from which they might deviate into better paths. A copy of this confessedly imperfect work was sent to every institution in the kingdom. Since then some attempts have been made by other instructors to supply a series of lessons, but none have met with general acceptance. To this work teachers should at once apply themselves. A concentrated effort can alone be successful. None of the British teachers agree in considering the work published by Dr. Peet of New York as meeting their view of what is required, while there are several individuals among them fully capable of projecting and carrying out a preparatory course of instruction very superior to it. Nearly every teacher will agree with the writer of this article that no series of lessons hitherto published in England meets the views they entertain of what such a series should be, and it is to be hoped their attention, as a body, will soon be directed to this their most manifest want, and to the means of supplying it.

In the year 1857, the committee of the London asylum published an 'Illustrated Vocabulary for the Deaf and Dumb.' This work contains 4000 woodcuts of objects, with their names arranged *alphabetically;* the engravings are generally well-executed, but the arrangement is as bad as could be adopted. One-half the expense incurred, with a suitable distribution of lesson-matter, would have given our institutions a book of immense practical value to them. In its present form, it is a capital family picture-book, without reference to the deaf and dumb, but only where price is no object; to the latter it is of little value, except as a dictionary or book of reference. Every teacher of the deaf and dumb is ready to contradict the statement put forth, that it is "eminently adapted to assist teachers in their endeavours to impart to the deaf-mute a knowledge of language through the faculty of sight, and to enable him to use words as the expression of his thoughts, and as the means of communication with his fellow beings." The woodcuts, however, might be rendered very serviceable under a different arrangement, with a comparatively small number of additional ones. If one portion of the work were made quite elementary, consisting of a certain number of easy nouns, printed on one side or on both, and purchasable in either form, many copies of such portion would be required in every institution, for beginners spoil many copies of their first books or lessons. This portion might be followed by successive ones; as examples of the singular and plural, of adjectives, of prepositions, of verbs, of adverbs; and other grammatical forms of language might be represented with little more labour than re-arrangement. The republication of the work thus disposed, in parts, would be a boon to both teachers and pupils, and really assist deaf-mutes in obtaining some "knowledge of language through the faculty of sight." A wealthy establishment might undertake this task, and the committee of the London asylum, having the charge of this 'Illustrated Vocabulary' bequeathed to them by their late principal, would thus make it widely available to the deaf and dumb of this and other countries, for its use should by no means be confined to the English language; the French, the German, and other continental schools, would doubtless avail themselves of it, if published in a form acceptable to them. For want of such an arrangement as is here suggested, and in order to make the present work available, several institutions have used *two* copies to make *one*, by cutting out the whole of the pictures, and remounting them in a progressive and classified form. *Abacus, abbess, abbey, abbot, abyss, acacia, acanthus, acclivity,* and *accountant,* are certainly not the first words a teacher would bring under the notice of his deaf and dumb pupils; instead of them he would select the names of common objects, known to the children, short, and easy of imitation in writing, such as *hat, nut, pin, pen, cat,* &c. It is to be hoped that a future edition of the work will be published under some such progressive arrangement, and that in other respects it will be freed from the grave faults ascribed by Degerando to Massieu's 'Nomenclature,' which criticism applies very forcibly to it in its present form.

Annual subscriptions, together with payments on behalf of pupils, effect much towards the support of this class of institutions, and the deficiencies are generally supplied by donations and legacies. Still the idea is gaining ground that as government aid is so freely rendered to all educational purposes for which it is sought, its application to our deaf and dumb establishments would be desirable, and would not be refused. The form in which such grants should be asked is a question for consideration, perhaps that of payments to assistant-masters would be one eligible mode of help. If each provincial institution could receive, according to its magnitude, from 50*l.* to 100*l.* a year in augmentation of the salaries of assistant-masters, a better payment to this class of teachers would be secured, and a succession of teachers might thus be relied on. There are no prizes in this department of education, the few chances of advancement to head-masterships are not sufficient to tempt young men to remain attached to institutions when so many openings for them occur in commercial houses, in joint-stock companies, and in the public service. Many good teachers would be retained in institutions, who at present seek places of greater emolument, if they could see the prospect of a second-mastership with such an addition to their salaries as would insure them 80*l.* or 100*l.* a year, besides board and lodging. Another boon the committee of council might confer on these institutions is the privilege of grants of books, maps, pictures, and diagrams, or the purchase of the same as by ordinary schools. Grants in aid of buildings, and extensions of existing establishments are also needed in many localities, but not so much for the purpose of additional institutions, as to render those in operation more efficient. Schools of fewer than 50 pupils do not carry on the work economically, and it is not desirable to multiply such schools. But it must be borne in mind that one-eighth of the deaf and dumb population should be provided for. It has been shown that Great Britain and Ireland contain 17,300 deaf and dumb persons; that 1550 only are under instruction, while 2175 is the due proportion; the deficiency therefore amounts to 625, yet to be brought into our schools.

These grants would probably not be conceded unless accompanied by government inspection; to this we apprehend no objection would be raised either by committees or by principals of institutions, provided the inspector was himself a teacher of the deaf and dumb. No other inspector could go through the examinations required satisfactorily to all parties, nor make due allowances for the difficulties attendant on such a course of teaching; each child would have to be examined in every branch of instruction, and from a week to a month, according to the number of pupils, would be required in the examination of each institution, and reporting thereon.

Besides the ordinary public institutions for the education of the deaf and dumb, another class has arisen in London, Manchester, and Leeds during recent years, while their especial object is met in other localities also, as at Birmingham, Glasgow, Belfast, and Bath. A description of one of them will show the operation of all, and that of London may be taken as their type, premising, that in the metropolis some objects are pursued which are not called for in the provinces. The chief feature of the association in aid of the deaf and dumb, in Bedford Row, London, is to supplement the work commenced in ordinary schools. The deaf and dumb are certainly more isolated than any ordinary class of persons, while they are naturally inclined to seek each other's society. By assembling them for week-day lectures, and Sunday instruction, the powers of mind of adults, especially those of the inferior class in intellect, are prevented from collapsing, or falling into a state of normal weakness. When they meet on Sundays the prayers of the church of England are read by signs, and plain explanations of some portion of the Liturgy, and of a passage from the Bible, are given, so that they can understand such instructions. Another important sphere of usefulness is home-visiting, by which the missionary employed becomes acquainted with their personal habits and wants; work is procured for the unemployed, and this part of the operations of the association has been attended with considerable success, for during the last three years regular employment has been obtained for about *forty*. Pecuniary loans have been advanced to about *sixty*, in times of temporary want or distress, and though on some occasions these loans become gifts, there is generally much good feeling exhibited in the repayment of such advances when the recipients are again earning wages. Occasional tea-meetings are held, and lectures are given on literary and scientific subjects in which the members evince much interest; in many cases drunken habits have been superseded by temperance, and steady industry has taken the place of an idle life. These are no trifling effects to produce, and they are all of that tendency which must increase the self-respect and self-dependence of the class thus benefited. At Manchester and Leeds several of the above objects are also carried out; at Glasgow, Birmingham, Bath, &c., Sunday services are held for the former pupils of those localities.

Within the last few years the literature which concerns the deaf and dumb, has received a valuable accession by the publication of two works in the French language, one by the Abbé Carton, director of the institution for the deaf and dumb, of Bruges; and the other by M. Valade-Gabel, honorary director of the Imperial institution for the deaf and dumb, at Bordeaux. We must explain how these two works originated. In 1833 the central society for the education and assistance of the deaf and dumb of Paris, declared their intention to award a prize for a work on the education of the deaf and dumb which should be applicable to home instruction and to common schools. In answer to it only two competitors appeared, while it was considered that neither of the works fulfilled the conditions of the offer, and no award was made. In 1855 the proposal was renewed, and produced eighteen competitors, to one of these, the work by the Abbé Carton, the prize was adjudged; another by M. Valade-Gabel, was considered entitled to very high distinction: these are the two works before us, four others were honourably mentioned.

The Abbé Carton's is distinguished by much simplicity and great clearness; it is not merely instructive, but it is also attractive. In an interesting and somewhat dramatic story the processes of teaching are unfolded in logical sequence, and connected with each other throughout the work. Petit Paul, the hero of the process, is the deaf and dumb child of the mayor of a commune in France, and a great favourite with M. Thomas, the modest and enlightened teacher of a common school, who had been the teacher of most of the fathers and mothers of the young generation, and who was universally esteemed for his useful life, as well as for his personal merits. A professor of the art of instructing the deaf and dumb takes especial pains to persuade M. Thomas, against his own will, that it is his duty to undertake the instruction of little Paul; that such a work would not only be easy but also pleasant. He undertakes the task, and step by step his efforts are conducted to a successful issue under the guidance of the professor. The work abounds in philosophical interest, it is written with great elegance of style, and displays an accurate knowledge of the difficulties to be surmounted, but it does little more than trace the outline of the plan to be pursued, and it would require a more practical development of every step taken to make it a useful guide to French parents and schoolmasters.

The work of M. Valade-Gabel enters largely upon the whole theory and practice of instructing deaf-mutes, and is one of the most able, and at the same time, interesting works which a teacher, whether of the deaf and dumb, or of an ordinary school could study. It will be suggestive to both, it may make a teacher of a common school, who enters into its spirit, forsake his vocation to become a teacher of the deaf and dumb, but it can never make him fulfil the scholastic duties which would devolve upon him with both these classes of pupils. The work comprises a series of practical lessons superior to any others we have seen in the French language, but we do not consider that either this work or the Abbé Carton's fulfils the proposal of the central society, nor do we consider that object an attainable one. The Abbé Carton's volume is entitled to high commendation as an attempt to popularise the instruction of the deaf and dumb, and it will serve to show parents and others how difficult is the art in practice, while it may encourage a few who have leisure and inclination, to prepare their children's minds for the professor. M. Valade-Gabel's work is a truly philosophical treatise brought down to the comprehension of common minds, but not to the practice of common schools.

On this subject we must refer again to Mr. Day's report on the German schools. He found some common schools in which the instruction of the deaf and dumb is carried on with that of children in the possession of all their senses. This theory was advanced in England about thirty-five years ago by the friends of a deaf and dumb person named Arrowsmith. The results in Germany are far from flattering; it was found that two years of separate preparatory instruction were first necessary, and then two hours of additional instruction daily, and the result was, that the deaf and dumb scholars were taught with the other pupils only in a few mechanical exercises; such as arithmetic, writing, and copying from dictation. There is another class of schools for deaf-mutes in some of the German States, connected with seminaries for the education of teachers for the common schools, but in the operation of this plan two very important preliminaries are overlooked: 1st, that long experience and peculiar qualifications are necessary to form an accomplished teacher of the deaf and dumb; and 2ndly, that in order to succeed, the teacher's whole attention must be devoted to the work. Another attempt to popularise the education of the deaf and dumb in Prussia is the advocacy of day-schools instead of boarding-schools; it is contended that on the German system of teaching articulation and reading on the lips, any newly-acquired power of speaking may be put into immediate practice, and that thus their facilities of utterance would be increased and improved, as well as their power of reading from the lips of others. But this is mere theory, for which present results should not be compromised; by its adoption none of the advantages looked for would be realised, while the deaf-mutes, as a class, would lose that careful training, watchfulness, and moral guidance which a residence in a boarding institution confers. Mr. Day mentions that some of the German schools are designed for the deaf and dumb and the blind. It is said that this unnatural union is rendered necessary only from economical reasons; this is scarcely a sufficient excuse for either these schools or those in the United Kingdom, in which the two classes are received. We doubt if it is a wise economy, for there is no common union either in the modes of instruction or in the other processes of education.

Institutions for the deaf and dumb have been established for rather more than forty years in America, and are fast extending to all the States of the Union. That at Hartford, Connecticut, was commenced in 1817; New York in 1818; Philadelphia, 1821; Danville, Kentucky, 1822; Columbus, Ohio, 1826; Staunton, Virginia, 1839; Indianopolis, Indiana, 1843; Knoxville, Tennessee, 1844; Raleigh, North Carolina, 1845; Jacksonville, Illinois, 1849; in South Carolina, 1849; Louisiana, 1852; Wisconsin, 1851; Michigan, 1854; there are also institutions in Iowa and Missouri. We have not space for particulars respecting these institutions; in the aggregate they educate upwards of 1600 pupils; they are carried on in a vigorous spirit by zealous and intelligent teachers, and they are fulfilling their purposes as well as those in our own country; though, in some respects, they are carried on under disadvantages which are unknown to the schools in the British Isles.

The Canadian government established an institution for the deaf and dumb at Montreal a few years ago; it is understood to be flourishing, but we have been unable to obtain any particulars as to its extent and progress. In the year 1856 a small institution was commenced at Halifax, Nova Scotia, which has recently increased in extent, and received much public favour; according to the Annual Report (1859), it contains twenty-seven pupils, several of whom are adults.

The advantages which have resulted to the community from the education of deaf-mutes have been large and important. The class itself, as an item of this public good, is brought from the normal condition described in the earlier part of this article into that of intelligent moral beings, awakened to the tenure by which human life and citizenship are held, and to the hopes which religion inspires. In the every-day business of life we find a fair proportion of deaf-mutes occupied in workshops, counting-houses, studios, and various other offices, who by industry and trained skill support themselves creditably, and whose general good conduct entitles them to respect. Without instruction these persons could not have been producers, but would generally have been a burden on the industrious classes. The art and science of primary education have also been gainers from the experience acquired in simplifying knowledge for the instruction of the deaf and dumb, whose teachers work upon the ignorance of their pupils rather than on any supposed acquirements. Children who have in the first instance to obtain their knowledge of language by single words, by short sentences, by visible objects or their representations, require the aid of black-boards, diagrams, pictures, plans, maps, models, collections of natural and artificial objects, and such other illustrations as the inventive talent of their teachers can suggest. The greater part of these accessories to instruction were employed in our deaf and dumb institutions for many years before they were recognised as legitimate aids by ordinary teachers. The time has arrived when they are generally adopted, and by their means, simplified and improved modes of instruction have arisen in the majority of schools.

DEAFNESS, the sense of hearing diminished or abolished. Deafness is either congenital or acquired. When congenital, it arises from an original malformation of the ear, and is then always accompanied with dumbness. When acquired, it arises from a variety of diseases affecting different parts of the complex apparatus connected with the sense of hearing. Some parts of this apparatus are placed beyond the reach of examination, and the function of other parts is but imperfectly known: so that it is often difficult to ascertain the exact seat of the disease, still more difficult to ascertain the exact nature of the disease, and even when this is discovered, more difficult than all to apply an effectual remedy. Hence the study and treatment of deafness are attended with peculiar difficulties; yet the subject has by no means engaged such a share of the attention of the scientific surgeon and physician as its importance deserves.

Deafness may arise from disease of the organ of hearing, or from disease of the brain. The organ of hearing consists of two parts, that destined to collect and transmit sound to the auditory nerve, and that composed essentially of a peculiar arrangement of the sentient extremity of the auditory nerve destined to receive sound and to transmit the impressions to the brain.

That part of the apparatus whose office it is to collect sound is termed the auricle, or the external ear—the ear commonly so called. [EAR; NAT. HIST. DIV.] From the auricle proceeds a narrow winding passage, termed the external auditory passage (*meatus auditorius externus*), which is closed at its farthest extremity by a membrane called the *membrana tympani*, or the drum of the ear. Beyond the membrana tympani is the cavity of the tympanum, which is a chamber of air, containing a curious and complex apparatus, put in motion by the vibrations of the air that produce sound. These vibrations are communicated to the internal apparatus by the membrana tympani, or drum of the ear, and, variously modified by that apparatus, and communicated to the air in the chamber of the tympanum, are conveyed to the internal organ, or the ear properly so called. Besides all this there is the passage called the Eustachian tube, which leads from the throat to the cavity of the tympanum. All these parts of the ear are subject to various diseases, any one of which is capable of impairing in a greater or less degree the sense of hearing, or of producing deafness.

Any considerable malformation of the auricle, or external ear, whose office it is to collect the vibrations of the air that produce sound, is found to occasion a greater or less degree of deafness. But the external auditory passage is lined by a vascular and highly sentient membrane, studded with organs of secretion, by which are elaborated the cerumen, or wax, with which the passage is kept in a state of moisture, and by which it is defended from the entrance of external bodies. A certain quantity and a certain quality of this secretion are indispensable to a sound condition of the function of hearing. If the secretion be diminished or suppressed, the hearing becomes extremely imperfect; if it be increased and thickened, the hearing may become altogether abolished. The quantity and quality of this secretion may be changed, in either of these modes, by many diseases; by inflammation, for example, induced by the application of cold and other causes. Accordingly, a vitiated state of the secretion of the wax, which may be accumulated in such a degree as completely to block up the passage, and so to prevent the transmission of sound to the internal ear, is among one of the most common causes of deafness. But inflammation may pass into ulceration; purulent matter may form, collect, and completely obstruct the transmission of sound. Moreover, morbid growths, as polypi, may spring from the lining membrane of the meatus, and plug up the passage. In these different modes there may be a complete obliteration of the auditory passage. This obliteration of the auditory passage is ordinarily attended with the total abolition of the sense of hearing; yet cases are on record in which the canal has been reduced to less than a line in diameter, and in which its walls at different points have even touched, without a great degree of deafness having resulted. In these cases, instead of deafness, there has been a constant noise or buzzing in the ear. Occasionally, though very rarely, there is the opposite state of the auditory passage: it is preternaturally enlarged; in one case it was so much enlarged, that the ring-finger could easily penetrate to the bottom of the canal. Deafness equally resulted from this enlargement of the auditory passage as from its obliteration.

The diseases of the auditory passage may be communicated to the membrana tympani, which may be inflamed, thickened, ulcerated, and rendered wholly incapable of performing the office of transmitting sound. It has been observed to acquire a thickness as great as that of the sclerotic coat of the eye, by a successive deposition of adventitious membranous layers. It is then of a yellowish colour, and quite opaque. Deafness often coincides with this altered condition of the membrana tympani; but it is doubtful whether, if this be the sole affection, it be capable of abolishing the sense of hearing.

The membrane which lines the chamber of the tympanum may partake of the diseases of the parts of the auditory apparatus which are external to it, or it may itself be the primary seat of disease. It may become inflamed and thickened, in consequence of which the capacity of the chamber for containing air must be proportionally diminished. The fluid commonly secreted by its membrane may be increased in quantity and vitiated in quality, and this increased and vitiated liquid may occasion deafness by the exclusion of air from the chamber. Such an altered secretion occurs chiefly in children and young persons, whose mucous secretions in general are easily deranged. This accumulation may take place without any pain in the ear, without any discharge of fluid from the ear, and without any appreciable lesion of the auditory passage. It may be suspected to be the cause of deafness when the sense of hearing varies materially at different periods of the day; when the deafness is greatest in the morning, and is suddenly and manifestly increased by a damp day, or by exposure to a cold and humid atmosphere. There may also be an accumulation of pus or of blood in the chamber of the tympanum. Pus may be suspected to be accumulated in the tympanum when deafness follows severe pain in the internal ear, attended with other signs of inflammation; and when inflammation and ulceration of the auditory passage are either absent or exist only in a slight degree. Blood may be suspected to be contained in the chamber when deafness follows a severe blow on the head in the neighbourhood of the ear, or a fall, or any cause by which a preternatural quantity of blood is determined to the head. Whether the cavity of the tympanum be obliterated by an increased secretion of the fluid which moistens its walls, or by an accumulation of pus, or of blood, the effused matter is often spontaneously removed by absorption, and the sense of hearing gradually returns as the process of absorption goes on.

One of the conditions essential to the sense of hearing is a free passage of air to the chamber of the tympanum through the Eustachian tube. But the diameter of this tube may be diminished or wholly obliterated by an accumulation of the mucus which moistens its internal surface, by the thickening of its lining membrane, and by the adhesion of this membrane at different points. The entrance of air into the Eustachian tube may also be obstructed by various diseases of the throat, as inflammation attacking the soft palate and the tonsils, the consequent enlargement of the tonsils, which may cover and completely close the opening of the Eustachian tube. The inflammation may also spread from the throat into the Eustachian tube; hence the pain in the ear and the deafness which so often accompany severe sore throat.

The internal ear, or that part of the auditory apparatus in which the impression of sound is received, the true and proper ear is, without doubt, subject to its own diseases; and it is probable that a very slight change in this delicate structure is sufficient to occasion deafness. But this organ is placed so far beyond the reach of examination, and the function of its different parts is so little understood, that its morbid changes, as the causes of deafness, are alike obscure during life, and difficult to be appreciated by inspection after death. The same is true of the diseases of the nerve which transmits the impression from the internal organ of hearing to the brain, and of the diseases of the brain itself. We know that it is indispensable to the sense of hearing that this part of the auditory nerve be sound, and that that portion of the brain with which the auditory nerve is in immediate communication be sound; we know that the auditory nerve and the brain are both subject to numerous diseases which impair or abolish their functions. The substance of the nerve may be diseased, or a tumour may press upon it in some part of its course to the brain; the brain may be diseased, inflamed, softened, hardened, oppressed by the effusion of water, lymph, pus, blood, or by the growth of tumours in its substance, occasioning general diseases, the most severe to which the body is subject, as phrenitis, hydrocephalus, epilepsy, apoplexy, &c. Among the local morbid phenomena produced by these diseases, deafness is always one. Often also this malady immediately follows repelled cutaneous eruptions and retrocedent gout, and it is the frequent concomitant of fever. In all these cases deafness is the consequence either of disease of the brain, or of disordered secretions of the auditory apparatus, or of both conjoined; and the hearing always returns as these diseases diminish and disappear.

When deafness arises from inflammation of the auditory passage, the deafness can be cured only by the removal of the inflammation, which must be treated according to the principles proper for the treatment of inflammation in any other part of the body. When deafness results from a disordered action of the follicles which secrete the wax, it is often removed by introducing into the auditory passage, night and morning, a dossil of cotton, containing some stimulating substance, as camphor, ammonia, or alcohol, suspended in almond-oil. When the auditory passage is loaded with hardened wax, the ear should be syringed night and morning with warm milk and water, or soap and water. When polypi grow from the lining membrane of the passage, they must be removed by a surgical operation, and the proper precautions taken to prevent, or the proper remedies employed to remove, inflammation. When there flows from the passage an acrid or fetid discharge, the ear should be cautiously syringed night and morning, and counter-irritation kept up by repeated blisters behind the ear, or by a perpetual blister, caused by daily dressing the vesicated surface with unguentum lyttæ. When the deafness arises from a diminished secretion of wax, good effects have often been experienced by the employment of galvanism, which is found not only to occasion a grateful warmth in the meatus, but also considerably to augment the secretion of wax. When deafness arises from inflammation of the membrane which lines the chamber of the tympanum, and from the consequent thickening of the membrane, or the effusion of fluid into the cavity, the most effectual remedies are blisters behind the ears and active purgative medicines. When closure of the Eustachian tube is the cause of deafness, the imperfection of hearing is often immediately removed by perforating the membrana tympani, this operation immediately establishing a free communication of air to and from the tympanum. When deafness is the consequence of disease of the auditory nerve, or of the brain, the nature of the nervous or cerebral affection must be discriminated and ascertained before any remedy can be applied with the slightest chance of success; and even when this is accomplished, it is too often only to satisfy us that the disease is beyond the reach of art.

DEALS. A term originally applied to the thin slabs of timber cut out of log-stuff; but of late years it has been exclusively appropriated to such as are sent from timber-growing countries, in pieces from 8¼ to 9 inches in width by 3 inches in thickness. Deals are sold in London by what is called the St. Petersburg standard, whatever may be their length, the standard being considered to be 120 deals of 12 feet in length, or in fact 1440 feet lineal.

The best yellow and white deals for ordinary joiner's work are obtained from St. Petersburg, Christiania, Gefle, Dram, Dantzic; the best spruce-deals come from Christiania and Gefle; the best pine, red or yellow, deals come from St. John's in New Brunswick, and Portland in Maine; and the best pitch-pine is obtained from the ports of Georgia and South Carolina. The present duty upon deals is calculated upon the same rates as that upon battens; or 10*s.* per load of 50 cubic feet when imported from foreign countries, and 5*s.* per load with 5 per cent. additional when imported from British possessions.

The timber duties, some years ago, were so ill-regulated, in regard to the different rates charged on deals of different dimensions, as to interfere greatly with the natural course of trade. When the duty was charged at a fixed rate per great hundred (of 120) without reference to dimensions, and when that duty was on a moderate scale, it was the practice in the wood-producing countries to cut deals of those dimensions which would produce the greatest cubical quantity of sound wood from each tree; and it then rarely happened that deals were longer than 12 feet; but when the duty was greatly increased, and was charged according to their dimensions in classes with varying intervals, it became an object to introduce as much wood as possible at each specific rate of charge, and without due regard to economy in cutting. It is naturally to be expected that, with a rate of duty forming a large per-centage upon the first cost of the article, no person would import any deals much short of each of the maximum dimensions admissible at each rate of duty, but would sacrifice a part of the material when necessary, in order to escape a higher rate of charge; by this means the cost was necessarily enhanced to the consumer. The same motive did not operate with respect to the lower taxed deals of the English colonies, nearly the whole of which were accordingly brought of such dimensions that the duty amounted to one-third more upon the cubical contents than it would amount to if the importers availed themselves of the provisions of the law in the way adopted by the importers of European deals. The duty charged upon the deals of Sweden, and still more upon those of Norway, was, by the working of the system, much higher than upon the shipments from Russia and Prussia; this arose partly from the different sizes to which the trees grow in the respective countries, and partly from the difficulty experienced in Sweden and Norway in conveying the trees, after they are cut, down rapid or narrow rivers to the place of manufacture. In France, where the duties on timber are low, deals are imported of all sizes suited to the convenience of the producers, and consequently the price is lower to the consumer; besides which, the quality of the wood is in some instances better, because thinner deals than are brought to England may be cut from the best part of the tree nearest to the sap. The deals of North America are inferior in strength and durability to those brought from the north of Europe, and to these last the preference is usually given for the flooring of houses and other purposes where durability is of importance. In building smaller houses, where cheapness is the principal consideration, Canadian deals are used. For small articles, such as mouldings, picture-frames, hat-boxes, musical instruments, as well as for many of the internal fittings of houses, and other purposes which call for the employment of wood that can be easily worked, Canada deals are preferred.

DEAN (French *Doyen*, and in Latin *Decanus*), a word which, at first sight, would appear to be allied to DEACON, but which has probably a different origin. Etymologists seem not to be agreed concerning the origin of the word; but the most usual origin assigned to it is the word *decem*, ten, as if a dean were a person who presided over collective bodies of men or things, in number *ten*. The word *Dean* is generally used as an ecclesiastical term. The French word Doyen is applied both to ecclesiastical and lay personages. Richelet ('Dict.,' art. *Doien*) says, that when applied to other than ecclesiastical bodies, it signifies the oldest of the body; thus the French used to speak of the Doien des Conseillers du Parlement. The Italian word *Decano* also signifies the head of a lay corporation, as well as an ecclesiastical dignitary. In Scotland it is used for the head of lay communities, but in England we believe it is generally confined to promotions or presidencies spiritual. It is, however, used in some colleges, as in University and King's Colleges, London, to signify the chief or head of a faculty chosen for a limited period. Deans in the colleges of Oxford and Cambridge are persons appointed to superintend the religious service in the college chapels, to enforce the attendance of the students there, and to exercise some control over them in other respects. In Scotland it is used as a lay title.

In England there are three classes of ecclesiastical presidencies to which the title Dean belongs:

1. *Deans rural.* The dioceses are divided into archdeaconries, and the archdeaconries into deaneries, below which there is no other subdivision till we come to parishes, the minutest of the proper ecclesiastical divisions of the country. The whole country is thus divided, with the exception of certain districts of no great extent, which claim to be exempt jurisdictions.

Those who contend for the derivation of the word dean, whence deanery, from decem, suppose that originally there were *ten* churches or parishes forming each of these deaneries. This is a very obscure point, and it is equally uncertain at what time this distribution of the dioceses was made. It appears, however, that there were deaneries before the Norman Conquest.

In each of these deaneries there was a clergyman who was dean; he was usually a beneficed clergyman within the deanery. His duties were to exercise a superintendency over the clergy, to preside at their assemblies, and to be the medium of their communication with their spiritual superiors. He had his public seal. He appears also to have discharged those duties which are now performed by clergymen called surrogates.

By degrees this office in the English church fell into disuse. The history or the reason of its decline is not very well known, for the advantage of having such an officer, especially where the archdeaconries were extensive, must have been always evident. The office, however, did by degrees disappear in one diocese after another, till it became totally lost. There was a dean of Chalke, in the diocese of Salisbury, as late as the reign of Charles II.; and a dean of Doncaster, in the diocese of York, in the reigns of George I. and II.

Attempts have been made to revive it. Berkeley, bishop of Cloyne, tried to establish the office again in Ireland; and soon after the late Dr. Burgess was made bishop of Salisbury, he did actually revive the office in that diocese, appointing Mr. Dansey, the rector of Donhead St. Andrew, rural dean of Chalke: this was in 1825. The Report of the Ecclesiastical Commissioners, 1835, under the head Territory, recommends that each parish shall be assigned to a deanery, and each deanery to an archdeaconry. There is a work, in two volumes quarto, entitled 'Horæ Decanicæ Rurales, being an attempt to illustrate by a series of notes and extracts, the name and title, the origin, appointment, and functions, personal and capitular, of Rural Deans,' by William Dansey, 1835.

The office existed in other parts of Christendom.

2. *Dean in a Cathedral Church.* The canons who formed the bishop's council were presided over by a dean; this has been the case from the remotest times. [Canon.] *Decanus et Capitulum* is the form in which all the acts of such communities run.

Anciently the deans were elected by the chapters; but here, as in other points, the royal power has encroached on the privileges of the Church. Now the form is for the crown to issue a *congé d'élire*, naming the person whom the chapter is to choose, in the bishoprics of ancient foundation; but in the bishoprics founded by Henry VIII., the king names the dean by his letters patent merely. In the former case the bishop is called in to confirm the election, and he issues his mandate for the installation of the person elected. In the bishoprics of St. David's and Llandaff the office of the bishop and dean is united in the same person.

3. *Deans in Peculiars.*—There are in England certain ecclesiastical promotions, in which the person holding them is called by the name of dean, and they seem to have all had anciently, as some of them have now, capitular bodies connected with them, and in all there is something peculiar in reference to their spiritual superiors, and in the jurisdiction exercised by them. The principal of them are—the dean of Westminster; the dean of the chapel of St. George, of Windsor; the dean of Christ Church, Oxford; the dean of the Arches; the dean of the King's Chapel; the dean of Battel; the dean of Bocking; the dean of Middleham, &c. If the history of these foundations were traced to their origin, it would be seen that they were ecclesiastical establishments, mostly of royal foundation, possessing peculiar privileges and a peculiar jurisdiction, which escaped dissolution when the framework of the ecclesiastical institutions of England underwent some alteration at the time of the Reformation. There are also *Honorary Deans*, as the dean of the Chapel Royal of St. James's Palace. The Bishop of London is dean of the province of Canterbury, and the Archbishop of Canterbury sends to him his mandate for summoning the bishops of his province in Convocation.

DEAN OF GUILD, in the municipal system of Scotland, is, as the title will naturally suggest, an officer of the merchant guilds, or societies of trading persons. An officer with this title used generally to be a member of the town council of every burgh, large or small; but by a clause in the Burgh Reform Act of Scotland (3 & 4 Wm. IV. c. 76, sec. 24), the functions of the dean of guild are appointed to be performed in each of the smaller burghs by some member of the council, chosen by the majority; and an officer chosen by the guildry, and entitled to sit as a member of the council, became peculiar to Edinburgh, Glasgow, Dundee, and Perth. By the Act 1593, c. 184, the dean of guild was invested with extensive judicial powers in commercial questions, but this jurisdiction has long been in desuetude. His principal powers are now of an ædile character. They are consuetudinary—not fixed by any general law, but dependent on the local customs of the various towns, so far as these have not been checked in their divergence from a general principle by the decisions of the courts. His authority is thus defined: "It belongs to the dean of guild to take care that buildings within burgh be agreeable to law, neither encroaching on private property, nor on the public streets or passages, and that houses in danger of falling be thrown down." The dean's authority is generally exercised in a court, of which he is the sole or the principal judge, according to local usage. His proceedings are sometimes conducted with the advice of a professional assessor.

The want of such an officer has been much felt in England; where somewhat analogous powers have latterly been conferred on Town Councils and Local Boards.

DEBENTURE (Latin, *debentur*, from *debeo*, to owe), formerly written debentur, is a kind of certificate used at the Custom House, which entitles a merchant exporting goods, upon which a drawback or bounty is allowed, to receive payment. The word has been used in some acts of parliament to denote a bond or bill, by which the government, railway, and other companies, are charged to pay a creditor or his assigns the money due on auditing his account. Debentures were used to secure the arrears of pay to the soldiery during the Commonwealth, and are mentioned in the Act of Oblivion, 12 Car. II., cap. 8. They are in use now in the receipt of Exchequer.

DEBT, ACTION OF, lies for the recovery of a sum certain, or capable of being ascertained, due upon bond, deed under seal, or simple contract, or upon the judgment of a foreign or colonial court. It may also be maintained against a gaoler for the escape of a prisoner in execution, or upon a statute by the party grieved, or by common informer. Previous to 3 & 4 Will. IV. c. 42, the defendant in an action of debt on simple contract (except for rent) was allowed to wage his law, for which reason the action of *assumpsit* was frequently preferred; but the action of *debt* has ever since been the better remedy in such cases, the judgment being final in the first instance; and the distinction between the actions of *debt* and *assumpsit* has now been abolished for all practical purposes by the Common Law Procedure Act of 1852. The action of debt will not lie for money due by instalments till all the days are past, unless the payment be secured by a penalty, or the amount to be paid on each day be specified.

DEBT, NATIONAL. [National Debt.]

DECAGON, a figure of ten sides; but the term is most commonly applied to an equilateral and equiangular decagon, or a *regular* decagon. [Regular Figures.]

DECANTATION, an operation often resorted to both in common life and in chemical operations; it is the process of pouring off the clear portion of a fluid from that which contains suspended impurities, or from the impurities themselves when they have perfectly subsided. Sometimes this method is employed in order to avoid the use of filters; and there are cases in which it is preferable, as when the solution is so acid or alkaline that it would destroy paper or linen.

DECAPITATION, beheading; a punishment, in all probability, of very ancient date, and certainly known among the Greeks and Romans. Xenophon, at the close of the second book of the 'Cyropædia,' says, that losing the head was looked upon as the most honourable death. The decollation, as it is called, of St. John Baptist shows the existence of this punishment among the Jews under the Roman government of Judæa. Suetonius ('Calig.' c. 32) tells us that Caligula kept a soldier, an artist in beheading, who decapitated prisoners in his presence, fetched indiscriminately for that purpose from the gaols. Hoveden and Florence of Worcester agree that Earl Waltheof, who was beheaded by William the Conqueror in 1075, was the first Englishman who suffered that punishment.

In a manuscript quoted by Lysons, relating to the earls of Chester, it is stated that the serjeants or bailiffs of the earls had power to behead any malefactor or thief who was apprehended in the fact, or against whom guilt was proved by sufficient witness, or confession before four inhabitants of the four neighbouring towns; and it appears that the beheading of malefactors was the usual mode of execution in this county; for in a roll of 3 Edward II. it is called the custom of Cheshire. (Lysons' 'Magna Britannia,—Cheshire,' p. 299, from the Harl. manuscript 2009, fol. 34, b.)

From another part of this work it appears that criminals convicted of felony were punished in the same manner in the barony of Malpas; and that this power was even exercised by the several possessors of the moiety and fourth parts of that barony. In the 6 Edward II., David Bulkeley, serjeant of the peace to Richard Sutton, presented the heads of two felons executed for burglary; and Hugh Cholmondeley, serjeant of the peace to John de St. Pierre, presented the head of Thomas Burness, executed for theft, and had his fee called the radyng fee. (Ibid., pp. 677, 678, from the Harleian manuscript 2079, fol. 124 and 131.) The foresters of Hardwicke, in Yorkshire, had this punishment allotted to them for theft.

At a somewhat later period decapitation became a punishment more especially appropriated to the higher orders of society. Henry VIII. beheaded two of his queens. Elizabeth beheaded a sister sovereign. The High Court of Justice beheaded Charles I. In 1644, Archbishop Laud was condemned by the two houses of parliament to suffer death by hanging; and the only favour granted to him upon supplication, after delay and with reluctance, was, that his sentence should be changed to beheading. Losing the head still continues to be considered the most honourable mode of receiving capital punishment in England; but there has been no recent instance of its being inflicted. The last was in the case of the rebel lords of 1745.

In France, criminals capitally convicted are beheaded. [Guillotine.]

DECAY. [Eremacausis.]

DECEMBER. This month still retains the original name assigned to it in the Alban, and first Roman calendar adopted according to tradition by Romulus, in both of which it was the tenth, as the name signifies, or last of the year. Our Saxon ancestors called it Mıð-ƿınτeꞃ-monað, *mid-winter-month*, and ᵹehul or *yule-month*, from ᵹehƿeol, *a wheel*, emblematical of the sun's revolution or return in his annual course.

December was anciently consecrated to Saturn, and in it the saturnalia were held; Alexander ab Alexandro, in his 'Genialium Dierum Libri sex,' says to Vesta, the daughter of Saturn. In the Alban calendar this month consisted of thirty-five days. Romulus reduced it to thirty; and Numa to twenty-nine days. Julius Cæsar restored the day of which Numa had deprived it; and Augustus added another day, which it still retains. Commodus, who attempted to change the names of several of the months, with the assistance of his flatterers, gave that of Amazonius to this, in honour of his mistress, Martia, whom he delighted to see clothed in the Amazonian habit.

DECE'MVIRI, or ten men, the title of various magistrates or functionaries in ancient Rome.

1. *Decemviri legibus scribendis*, that is, ten men for the purpose of making a new code of laws, were certain extraordinary magistrates, or rather a commission of ten men, invested with the power both of framing a new code and administering the republic. In the early times of ancient Rome the judicial power belonged to the kings, and, after their expulsion, to the consuls, who did not decide according to written laws, but only according to usages and customs. As such usages and customs were necessarily subject to doubt, and as the consuls were chosen only from the patrician order, the disputes between patricians and plebeians were probably often decided partially in favour of the former; and this would happen more especially in criminal cases, for which no certain law was provided. These circumstances led to the institution of the decemvirs.

After many violent struggles, the senate and the plebeians, B.C. 453, agreed that certain written laws should be framed, to which every citizen, without any distinction, should be subject. A commission of three members was appointed to visit Athens for the purpose of getting a copy of Solon's laws, and making themselves acquainted with the institutions of other Greek states. (Liv. iii. 31.) The commissioners having returned at the expiration of two years, the tribunes immediately called for the new code. For this purpose another commission, consisting of ten members, was named by the comitia centuriata. Uncontrolled power, both administrative and judicial, without any appeal, and accompanied with the suspension of all other magisterial offices, including the consuls and tribunes, was conferred on them. The names of the ten commissioners are recorded in Livy (iii. 33) and Dionysius Halicarnassus ('Antiq. of Rom.' xi. 56). Appius Claudius was the leading member of the ten; he was the soul of the commission, and directed all the business. The decemvirs conducted themselves with great moderation and justice. On the expiration of their year of office, they had framed a body of laws, distributed into ten sections, which were approved by the senate and the comitia, and engraved on ten tables of metal.

As the new laws seemed imperfect in some respects, a new commission was named, at the head of which was the same Appius Claudius (Liv. iii. 35). But the decemvirs now began to behave in a very different manner; they became real tyrants, and formed a most pernicious oligarchy. They framed, however, several new laws, which were approved by the centuries and engraved on two tables. Though their commission and the year of their office were now at an end, they still would not resign, but continued to hold their power in the year 447 B.C. and to exercise it in a most arbitrary manner. Appius Claudius, by a most unwarrantable decision, declared Virginia, the daughter of Virginius, an officer in the Roman army, a slave, because she had refused to listen to his dishonourable proposals. Virginius, the father, to save his daughter from violation, murdered her in the public place, and, with the bloody knife in his hand, called on the people to take vengeance on their oppressors. Both the citizens resident in Rome and the army united themselves to overthrow the tyrannical power of the decemvirs, who were forced to abdicate, and the ordinary magistrates were re-established. Appius Claudius was put in prison, where he died.

The ten tables of the former and the two of the latter decemvirs together form the laws of the twelve tables.

2. *Decemviri litibus judicandis*, that is, ten men for the purpose of deciding suits, formed a court of justice under the superintendence of the prætor, which was established about B.C. 287. The establishment of this body was caused by the great increase of suits, which rendered it impossible for the prætor to get through the business of his court. As to the powers of these decemvirs, we have no distinct notices.

3. *Decemviri sacris faciundis*, were an ecclesiastical college, the members of which were elected for life. The care of the Sibylline books belonged to them, and they were consulted by them on important occasions.

4. *Decemviri agris dividundis*, were a commission for the temporary purpose of dividing lands among the colonists when a new colony was to be established.

DECIMAL FRACTIONS. [Arithmetic; Fractions.]

DECIMAL NOTATION. [Arithmetic; Numeration.]

DECIMAL SYSTEM OF WEIGHTS AND MEASURES. [Weights and Measures.]

DECLARATION (declaratio), in law, is the statement of his case by the plaintiff in an action at law: in a real action it is properly called a count (narratio). It corresponds to the *bill* in chancery, the *libel* in ecclesiastical courts, and the *petition* in the court of divorce. [Pleading.]

DECLARATOR, ACTION OF, a form of procedure peculiar to the Court of Session in Scotland. Its name explains its nature, which is an action to have it judicially declared that a certain right exists, with reference to property, or that a certain character, as, for instance, husband or wife, or heir or trustee, exists in a particular person or persons. It is not necessary that the party who brings the action should demand any immediate service from the law, or that there should be any adverse party. It may be raised by persons in doubt how they ought to act to avoid the consequence of a breach of the law, and thus it is frequently had recourse to by public officers. A person whose legitimacy is questioned, though no one may be at the moment denying his right to possess any property of which illegitimacy would deprive him, may bring an action of declarator of marriage and legitimacy to have his claim judicially established. The principle of the declaratory conclusion is often admitted into other actions where there are many complex claims. The court lays down certain rules, applicable to the circumstances, by which the claims of individual parties shall in the ultimate decision be tried. The action of declarator has been applied to many useful purposes, but it is likewise, like some similar forms of procedure in chancery in England, capable of abuse.

It has been proposed to vest a jurisdiction similar to that thus exercised by the Scottish courts, in the Court of Chancery; but the proposal has not yet assumed sufficient shape to permit of its forming the subject of legislation. The Court for Divorce and Matrimonial Causes has, however, by a recent statute, been empowered to declare the *status* of persons being or claiming to be natural born subjects of the Crown; by establishing their legitimacy or the validity of the marriage of their parents. (21 & 22 Vict. c. 93.)

DECLINATION. When a star is not in the equator, the angle made by two lines drawn from the spectator's eye, one to the star, the other to the nearest pole, is called its polar distance. The complement of the polar distance, or the angle subtended by the star and the nearest point of the equator, is the declination of the star. It is called north or south according as the star is north or south of the equator. The declination (it is becoming very common to use the polar distance in preference) and the right ascension [Ascension, Right] are the usual co-ordinates to which a star's place is referred. Confining ourselves here to declination, we must merely remark that the effect of a diminution in declination is to bring the star nearer to the equator, and its time of appearance above the horizon nearer to twelve hours. The length of a star's (or of the sun's) time above the horizon is found as follows: Multiply together the tangents of the latitude of the place and of the declination of the star. If the answer be greater than unity, the star is too near the north pole to set, or too near the south pole to rise (according as the declination is north or south); if equal to unity, the star grazes the horizon at the north (or south) points, but does not set (or rise); if less than unity, find the angle which has the preceding product for its cosine, convert it into time at the rate of 15° to an hour, and the defect from twelve hours is the half of the duration required, expressed in sidereal time.

DECLINATION OF THE MAGNETIC NEEDLE (or Variation of the Magnetic Needle), is the angle which the horizontal needle makes with the geographical meridian of any given place.

It has been usual among European writers to refer the discovery of the declination or variation of the needle to Columbus, on his first voyage of discovery in 1492. This opinion rests entirely on the testimony of the son of that great navigator, who states the circumstance in the life of his father, with considerable probability of its being a real case. It is however hardly to be conceived, that the compass should have been in use amongst the enterprising sailors of Europe, upon voyages so extensive as were then frequently undertaken, without the circumstance being not only observed by some, but known to all who were engaged in maritime affairs. At all events, it appears from various printed works and manuscripts to have been familiarly known very soon afterwards to all the commercial nations of Europe.

When it was found that the needle declined from the meridian by different quantities in different places, it was still assumed that at each given place the declination was constantly the same. In 1581 Burrough published his 'Discourse on the Variation of the Compass,' in which he states as the result of numerous observations, that the declination at Limehouse was 11° 15′ E; but in 1633, Gillebrand, the Gresham professor of geometry, found by careful observations that it only amounted to 4° 5′ E. It has indeed been stated by Bond, that the variation of the declination was first discovered by Mair, and secondly by Gunter; but as he gives us no authority for this assertion, we are unable to judge of its truth or falsehood. Bond was addicted to paradox, and his statements should therefore be received with caution.

Careful observations (subject however, to several sources of then unsuspected error) have been made from that period down to the present time, and they all concur in showing that this variation of the declination is continually going on, though not with a uniform angular motion. It was therefore inferred, that the needle would continue to revolve round the horizon by slow degrees, till at last it came round again to any given position; and it appears to have been suspected by some, that the irregularity of its indicated motions was only apparent, and arising either from the imperfection of the instruments employed, or the inaccuracy of the observations themselves. The scientific world was, consequently, not prepared to expect the results of Major Sabine's observations on the declination, and the truth which they unfolded, when in 1818 he determined it to be 24° 30′ W., and four years afterwards to have retrograded to 24° 12′, at London. Subsequent observations, however, bear out this conclusion; and not only do the observations made in this country, but throughout Europe, undeniably establish the fact, that the western declination had about 1818 or 1820 attained its maximum value, and that the needle, instead of continuing to gradually move round the points of the horizon, is now returning towards the geographical meridian. The general opinion is therefore, that the needle performs a series of oscillations on each side of the meridian, and after attaining its extreme limit returns again through another slow oscillation. As no easterly declination equal in quantity to the recent westerly maximum value has been observed with care, we are left only to conjecture on this point. If, indeed, we adopt this hypothesis, and take Bond's authority for the declination being 0 in 1657, we ought to expect on such an hypothesis that it will be 0 again in 1979, and attain its greatest easterly value in 2140. We are not, we confess, very devoted believers in the opinion that its oscillations are regular; and we think we could furnish strong reasons for our scepticism on this head: but while so few steps have been made towards a satisfactory theory of terrestrial magnetism, it would be rash to affirm that conclusive reasons can be given for either one opinion or the other. At all events, the popular hypothesis depends entirely on an analogy supposed to hold true between the pendulum and the magnetic needle, in a case where the analogy is unphilosophically applied, that is, where the analogy of the causes is by no means apparent, and where there even seems to be a direct contrast between them.

The daily variation of the declination was first observed by Graham in the early part of the last century. He found by very careful experiments upon excellent needles, that the declination was not uniform during the whole period of a day; sometimes being to the east, and sometimes to the west of the general mean declination at the time and place of observation. Canton, less than half a century later, made a considerable number of observations, and a great number of experiments on a subject, which he, like Graham, supposed to be collateral with it,—the influence of temperature upon the intensity and direction of the needle. These inquiries were pursued with great success by Mr. Christie, of the Royal Military Academy, and M. Kupfer, of Casan. Separate parts, too, of this inquiry were attended with very curious results in the hands of Mr. Barlow, likewise of Woolwich Academy, on the influence of high temperatures; and by Colonel Beaufoy, in his careful observations on the actual daily variation for several years before his death.

This article is but a slight sketch of the general state of the science. We refer to the articles MAGNETISM, TEMPERATURE, and VARIATION, for details of the methods of observation and the theoretical views which have been proposed.

DECOCTIONS are formed by subjecting the harder parts of plants which are not easily penetrated by liquids, or are insoluble in water of a low temperature, to the process of boiling, generally in water, but sometimes in oil. By this means much of the substance is dissolved, and the active principles of the plant are imbibed by the fluid, which is then used medicinally either internally or externally. Porcelain vessels, or those glazed with salt (Bristol ware), are to be preferred to metallic vessels in most cases. This method of extracting the medicinal properties of plants is inadmissible when their powers depend upon any aromatic or volatile principle, such as essential oils, which are dissipated by a high temperature. In many other instances this process is not only unnecessary but injurious, being employed when infusion is sufficient, even when cold water is used for the purpose of infusion. Of this nature are all purely mucilaginous substances, such as marsh-mallow (*Althea officinalis*), quince-seeds (*Cydonia vulgaris*), &c., from which Trommsdorf has shown that a purer mucilage, which keeps longer, may be obtained by cold water. All substances, the astringent properties of which depend upon the presence of tannic acid, such as oak-bark, tormentil-root, &c., have their astringent power impaired or completely destroyed by long boiling. Besides, boiling dissolves many principles, such as starch, &c., which are quite inert, and which do not contribute to the efficacy of the medicine, while their presence disposes the decoction to decomposition, a process very apt to occur in decoctions, and rendering them unfit for use in a few days or hours. Decoction is a mode of preparing substances most suitable to those which are both nutritious and medicinal, such as Iceland moss (*Cetraria islandica*). But when the bitter principle alone is wished, cold infusion is better. Many principles which are dissolved by the water at a boiling temperature are deposited by it by cooling, on which account the liquid should always be strained while hot, and the contents of the bottle shaken up before each dose be poured out. Aromatic liquids are frequently added to the fluid after it is strained; or the aromatic substance may be placed at the bottom of the vessel into which the hot decoction is strained, and, after being allowed to infuse for a few hours, may then be applied to the use intended. A better method, however, is to add some aromatic tincture after the straining, as the presence of the spirit retards the tendency to decomposition, while it imparts the flavour and qualities of the substances from which it had been prepared.

To render the heat steady, or uniform, various expedients are resorted to, such as, more especially on the Continent, a *bain marie*, or sometimes Reindorf's apparatus; a steam or vapour bath is also used. In this country, where spirit of wine is expensive, gas has lately been used with excellent effect.

To bring the temperature of the water up to the proper degree as rapidly as possible, and thereby shorten the process, as well as lessen the risk of empyreumatising the ingredients, the introduction of a jet of steam is attended with advantage, especially in forming decoction of sarsaparilla.

To obviate some of the objections to decoctions, what are termed *Decocta infusa* have been introduced. The more insoluble substances are first put into the water, as in common decoctions, then after boiling half an hour or an hour, according to their nature, the more soluble matters, or the boiling water, charged with what it has dissolved, is poured on the other ingredients, and having stood the usual time, as for a common infusion, is strained. A better plan would be the entire disuse of decoctions.

DECOMPOSITION. When a compound body undergoes an entire change of properties, either spontaneously or from chemical agency, it is said to be decomposed; thus, during fermentation, whether the spirituous, acetous, or putrefactive, the substance undergoing it suffers decomposition, and its elements recombine so as to form new compounds. This distinguishes it from mere mechanical division, to whatever extent that may be carried. [ANALYSIS; FERMENTATION.]

DECREE, DECRETA'LES. The term decree (decretum) denotes a decision or order by a competent power or magistrate, by which some doubtful or disputed point of judicial inquiry is determined. In England, the final judgment of the Court of Chancery is usually called the decree. In Scotland, every judgment must contain a decree or decerniture, which is effected by using the word "Decerns."

It was usual among the Romans, in doubtful cases, to take the opinion of lawyers, which were called "responsa prudentum," obtaining the authority of law when they were unanimous. (Gai. 1-7.) When all legislative power was centered in the emperor, it became the custom to ask for his opinion in disputed cases. The decision was called a rescript, and at once became a part of the imperial decrees or constitutions.

In ecclesiastical matters the clergy, following out the precedent of the Roman empire, early introduced a practice of asking the opinions of the bishops, particularly of the bishop of Rome. The replies of the pope ultimately obtained great authority, though they had not the force of laws, so long as the legislative power belonged to the councils. In the 12th century, the pope being regarded as the highest ecclesiastical authority, the whole ecclesiastical legislation was centered in him, and the papal decrees became the only source of ecclesiastical law, as the imperial constitutions had been for the civil law. The decrees of the pope, which are called *decretales*, may be defined as decisions of the popes in ecclesiastical matters of law. The decrees of the popes retained their authority as law till the 14th century, when the power of the holy see began to decline. [CANON LAW.]

DECREE. [EQUITY.]

DECREMENT. [INCREMENT.]

DECREPITATION. A term applied in chemistry to the slight explosions produced when certain crystallised salts are suddenly exposed to a high temperature. The little explosions producing the crackling noise of decrepitation, are caused by small portions of water imprisoned within the crystals being converted into steam, which acquires sufficient tension to tear asunder the walls of the chamber within which it is confined. Common salt thrown upon a bright cinder fire affords a good illustration of decrepitation.

DECURIO'NES, a term which denotes certain persons who correspond to the senate at Rome, in the Roman towns and colonies in Italy which enjoyed free municipal rights. The body of the decuriones was called ordo decurionum, and in later times also curia decurionum, whence the members of the order were also designated by the name curiales. The whole administration of the internal affairs of such towns and colonies was in their hands. They were required to have a certain estate, and to be at least twenty-five years old. It is commonly said that their number was ten, but it was usually greater, and sometimes amounted to 100 members. At the head of the body were the duumviri, that is, two men, like the two consuls, who presided in the Roman senate. Those municipal corporations forming, as to their internal administration, little republics, the citizens had the right of choosing the duumviri just as the citizens of Rome elected their consuls; but under the emperors they were deprived of this privilege, and the decuriones at the same time lost their power. The municipal corporations were administered by officers appointed by the emperor; and the decuriones were only employed to receive the taxes, which subjected them to a great responsibility. The office of a decurion being now considered as a burden, was no longer sought after, and lost its former importance. (Sigonius, 'De Antiq. Jur. Ital.' ii. 4.)

DEDICATION. [CONSECRATION.]

DEED (in law), an instrument in writing or print, upon paper or parchment, comprehending the terms of agreement between parties able to contract, duly sealed and delivered. Deeds are of two kinds, indented and poll: a deed indented is called an indenture, and originally had, and indeed now sometimes has, a waving line cut (*in modum dentium*) on one of the edges of the material upon which it is written, usually the top edge, and when the deed consists of more sheets than one, on the first sheet only. The term indenture implies that the deed is of two parts, and that they were divided by the line in order to afford additional means of authentication; but, except in the case of leases, marriage settlements, partnership deeds, and some few others, there are seldom more parts than one. In deeds effectuating modern transactions, indeed, the expense of stamps is so heavy, that frequently, where two or more parties are equally interested in a deed, it is deposited with some person for their joint use. Hence the term indenture, in common acceptation, now implies little more than that the deed is made by and between two or more parties. Anciently some word, as, for instance, "chirographum" (whence "chirograph"), was written in capital letters upon the part where the parchment or paper was to be divided, and afterwards cut in an indented, or in some cases a straight line.

The stat. 8 & 9 Vict. c. 106, enacts that a deed executed after Oct. 1st, 1845, purporting to be an indenture, shall have the effect of one, though not actually *indented*.

A deed poll is cut even, or polled at the edges, and is usually of one part only; that is, the deed of one party, or of several parties of the same part. The form commences in the mode of a declaration: "Know all men by these presents, that," &c. The form appropriated to an indenture or a deed among several parties is, "This indenture, made, &c., between, &c. Witnesseth," &c.

A deed, to be absolute and irrevocable, must be founded on a valuable or good consideration, untainted by anything immoral, illegal, or fraudulent, though a gift or voluntary conveyance will be effectual as between the parties, and is only liable to be questioned in certain cases by creditors or subsequent purchasers; and a voluntary deed may become irrevocable by a subsequent sale by the grantee of the subject-matter conveyed by it.

Ancient deeds were short, and suited to the simplicity of the times. When transactions became more complicated, it was customary to divide deeds into several formal parts; but it is not absolutely necessary that a deed should be so divided, provided there are sufficient words to show the meaning and intention of the parties. These formal parts are: 1. The premises; that is, the date, the parties' names and description, the recitals, the consideration and receipt thereof, the grant, the description of the things granted, and the exception, if any. 2. The habendum, which defines the estate or interest to be granted. 3. The tenendum, which was formerly used to express the tenure by which the estate granted was to be held; but since freehold tenures have been converted into common socage, the tenendum has grown out of use. 4. The reddendum, the reservation of some new thing, as rent, to the grantor. 5. The condition (if any) annexed to the grant. 6. The warranty. 7. The covenants. The office of these two last, in modern conveyances, is served by special covenants for the validity of the title, and to do or abstain from doing certain specified acts. 8. The conclusion, which mentions the execution, &c.

Previous to its execution, the deed should be read, if any of the parties require it; or, as to that party, it may be avoided. The modern mode of executing deeds is by signing, sealing, and delivering. Signing is not essential to the validity of a deed, though it is required as to less formal instruments by the statute of frauds, 29 Ch. II. c. 3; but sealing is absolutely necessary, which is the most ancient mode of authentication, and has been in use from the earliest times. At present the seal affords no real security against fraud, for any impression upon wax or other substance employed is sufficient; indeed, it is generally affixed by the stationer who engrosses the deed, and it is not even necessary that there should be a seal for each party: one is sufficient for all. In some of the American states the impression upon wax has been disused, and a flourish with the pen at the end of the name, or a circle of ink, or a scroll, is allowed to be a valid substitute for a seal. The last essential to the due execution of a deed is delivery, except in the case of a corporation, where sealing by the common seal has the effect of delivery. The usual manner of delivering a deed is for the executing party to say, "I deliver this as my act and deed;" but any less formal mode by which the party signifies his intention to deliver it will be effectual. A deed may also be delivered as an escrow,—that is, to a third person to keep till something is done by the grantee: when the condition is performed the deed becomes effectual. A deed takes effect from the delivery, and not from the date; and, therefore, if it have no date, or a date impossible, the delivery ascertains the time from which it is to take effect. Evidence is admissible also of delivery on a day different from the date written. The execution is usually attested. Enrolment and registration are rendered necessary in some cases by statutory enactment, and the revenue laws have imposed certain stamps upon every description of deeds, the absence of which prevents them from being admissible in evidence.

The principal rules for the interpretation of deeds are, that the effect be fair and reasonable, and as near as possible to the apparent intent of the parties as the rules of law will admit; that the construction be made upon the entire deed, and not upon disjointed parts; that where the intention is clear, too minute a stress be not laid on the strict and precise signification of the words; and that if there be two clauses totally repugnant to each other, the first shall be received, and the latter rejected. There are many other rules of construction, which are exactly the same in courts of law and equity. Courts of equity also rectify mistakes in deeds, and give relief in cases of fraud, and where instruments are lost, &c. [Equity.]

After execution, a deed may became void by erasure, interlineation, or other alteration in any material part; but, generally speaking, such alterations will be presumed to have been made before the execution, if nothing appear to the contrary, or there be no cause to suspect that it has been done in a clandestine manner. A grantee may also disclaim the grant or disagree thereto; and a deed may be destroyed or cancelled, but such destruction or cancellation will not revest the thing granted in the grantor, though all personal engagements established by the deed between the parties will be put an end to.

A confirmation is an assent to an estate or interest already created, by which act the person assenting confirms and gives validity to the estate or interest so far as he can. A confirmation can only have this effect with respect to estates voidable or defeasible; it has no operation upon estates which are absolutely void. (Butl. n. Co. Litt., 295 *b.*)

(Shep., *Touchstone;* Dixon; Co. Litt.; Cruise's *Digest.*)

DEFAMATION; the speaking slanderous words of another. The injured party may bring an action to recover damages, but to enable him to succeed, it is absolutely necessary that the words should contain an express imputation of some crime or misdemeanor which would make him liable to punishment; or, if the words are not actionable in themselves, some special damage should be proved to have resulted from them to the plaintiff. There are certain cases, however, where words are spoken of a tradesman or professional person in the way of his trade or profession, as that a tradesman is insolvent, or that an attorney deserves to be struck off the roll, in which the plaintiff, by reason of the character he fills, may recover damages. Of the first class the following case affords an illustration. A churchwarden was accused by the defendant of having stolen one of the church bell-ropes: it was held that, as the property of the bell-ropes was vested in the churchwarden, the words did not impute a crime to the plaintiff for which he was punishable, and consequently that the action could not be maintained. In former times, actions for slander were very rare; and though it has been frequently said that actions for words spoken in heat or anger, suddenly and without deliberation, ought not to be encouraged, yet it has been truly observed (by Wray, Ch. Just.) that unless the party injured by false and malicious scandal had a remedy at law, it would lead to personal violence, and the consequences might be fatal. In most cases, malice in law may be inferred, but in actions for slander *primâ facie* excusable on account of the cause of publishing the slanderous matter, malice in fact must be proved; it is scarcely necessary to observe, that where special damage is proved, the existence of malice is immaterial. Defamation is also punishable in certain cases by indictment and criminal information. Where the slanderous matter is spoken of a peer, the offence is termed scandalum magnatum, and is made punishable by various statutes: this mode of proceeding however may be said to have become obsolete.

The ecclesiastical courts formerly had power to punish for defamation: but these courts could only inflict punishment by way of penance; they could not award damages; and this useless but mischievous jurisdiction has consequently been abolished. An action may also be maintained for slander of title to an estate or property; but in this case the plaintiff must prove malice express or implied: it is not sufficient that the defendant should allege title in himself, or make objections to the title of the plaintiff if he had reasonable grounds for so doing. (Cowel; M'Culloch; Selwyn, *N.P.*). [Libel; Slander.]

DEFEAZANCE (from the French verb *défaire*, to make void) is an instrument which defeats the force or operation of some other deed, estate, or interest, upon the performance of certain prescribed conditions. In this manner mortgages were formerly made, the mortgagor enfeoffing the mortgagee, and at the same time executing a deed of defeazance. Defeazances being discountenanced by the courts, as affording opportunities for fraud, have long ceased to be used as applicable to titles, it being far better to make the conditions apparent on the deed itself.

Defeazances to bonds, recognizances, &c., merely state the conditions on which the instrument is to be void. The defeazances to warrants of attorney and cognovits must be written upon the same paper or parchment as the instruments themselves.

DEFENCE OF FORTRESSES. [Siege.]

DEFERENT, a circle or oval curve on which the centre of another oval moves, while a planet is supposed to move round the latter. The term is one of the Ptolemaic Hypothesis. Thus the earth's orbit, to choose an example out of the modern system, is a deferent on which the moon's orbit is carried.

DEFILADING is that part of the art of fortification the object of which is to determine (when the intended work would be commanded by eminences within the range of fire-arms) the directions or heights of the lines of rampart or parapet, so that the interior of the work may not be incommoded by a fire directed to it from such eminences.

If it be required, with a given height of parapet, to approach obliquely as near as possible to an eminence, the following process is adopted, the situation of the rampart or parapet at that extremity of the intended line which is farthest from the eminence being also given. A line is supposed to be drawn from the commanding eminence, or rather from a point about eight feet above it, through another point which represents the crest or summit of the intended parapet at the given place, and to be continued till it intersects the natural ground in rear of that part of the line of parapet. This crest is considered as the vertex of a cone whose base is a circle, on the ground, having for its radius a line equal to the distance from the parapet to the rear extremity of the ground to be protected (which distance, however, must always be less than that of the intersection above mentioned). Then a line being drawn on the plan, from the point vertically under the given crest, parallel to a line drawn from the said intersection and touching the circle, will be the direction of the intended rampart or parapet, whose height must be everywhere equal to that which was given. By this construction all the lines of fire from the commanding eminence, and passing closely over the crest of the parapet, will be in a plane meeting the ground on that eminence, and touching the convex surface of the cone.

Again, if it be required, when the plan of the work is determined, to ascertain the heights of a rampart or parapet in different places, so that the interior may be protected from the fire of the enemy on a commanding eminence beyond, the relative heights of the principal inequalities of the ground with respect to some horizontal plane, technically called the plane of comparison (which generally passes through the highest or the lowest point), must be found by the spirit level. An oblique plan, technically called the plane of site, must be imagined to touch the summit of the eminence in front, to pass above all the intermediate ground, and to meet that in rear of the work; then the relative heights, with respect to the plane of comparison, of the several points in the plane of site which are vertically above the inequalities before mentioned of the natural ground, must be computed, and the differences (which express the heights of the plane of site above the natural ground in such places) being added to the given height which the rampart or parapet is to have above the plane of site, the sums will express the heights to which the works are to be raised above the natural ground at the same places.

When the work is of small importance, the elevations of the parapets above the ground are generally determined by the eye, thus: Pickets are planted in convenient places, chiefly at the angles of the intended work (the plan of which has been already traced on the ground), and on the summit of the commanding eminence, the picket in this place being about eight feet high. The visual rays being supposed to proceed from the top of this picket to two or more points, which must be also eight feet above the ground, in rear of the work, the intersections of these rays with the pickets planted on the magistal or ground line of the work, will show the heights to which the parapet is to be raised at those places in order that the interior may be effectually protected.

A similar process is employed when it is required to protect the defenders of any parapet from the fire of the enemy on a commanding eminence in their rear; in which case it is frequently necessary to raise, in the interior of the work, a mass of earth, which is called a traverse or a parados, according to its situation.

DEFILE, in military writings, is a name given to any narrow way. Every piece of ground which, in consequence of local impediments, can be passed by a column only on a narrow front, is called a defile. Such are roads along valleys, between walls or hedges, or over dykes raised across marshes. Sometimes also the term is applied to a street in a village, and to the path over a small bridge.

DEFINITE PROPORTIONS. [Atomic Theory.]

DEFINITION (*definire*, to mark out a boundary) is the process of stating the exact meaning of a word, by means of other words. From so boundless a subject, we can only select a very few points, such as have reference to the most common uses of the term. In the first place, it is evident that all definition contains a species of fallacy, if considered as an absolute determination of the meaning of words. *Quis custodiet ipsos custodes?* who shall determine the meaning of the words which make up the definition? The process of definition can never appear satisfactory unless it be considered as a transition from many words to the single term which it is agreed shall stand for their meaning, be that what it may. All attempts at absolute definition must end in confusion of ideas.

But at least, perhaps it may be said, the mathematical sciences are founded upon exactness of definition. Nothing is more common than this assertion coupled with another, namely, that these sciences depend entirely upon definitions. In a certain sense both are true, but that sense is not the most frequent meaning of them. The exactness of mathematical definition is not of arbitrary construction, but a consequence of the exactness of the notions which all men have, or may be made to have, upon the things which the words represent. There is no exactness in the fundamental definitions of mathematics, verbally considered, but only much confusion arising from the attempt to introduce conventional accuracy. The words "straight line" carry with them their own meaning, and even explain the attempt which is made to explain them; for no one would easily guess what sort of line it is which "lies evenly between its extreme points," unless he were aware that it is a "straight" line which these words attempt to describe.

Definition may either be purely nominal, or it may be such a description of the thing defined as amounts to a statement of some one of its fundamental properties. The first we see in the words "isosceles triangle," the definition of which is a simple announcement that we intend to use a Greek term. The second may be seen in the article Concave and Convex, in which the definition is made by means of an absolute mathematical property of the thing defined: the relative position of the spectator, the curve in question, and a straight line, do not enter into the notion which the words immediately suggest. The method of Euclid is to supply a rough and descriptive definition addressed to the common notion of the word, followed by an assumption of a mathematical property under the shape of an axiom. Thus a straight line is "that which lies evenly between its extreme points;" while the real definition, or distinction between straightness and every thing else is contained in the axiom "two straight lines cannot enclose a space." Every attempt at mathematical definition, which does not rest upon the selection of a substantive property of the thing defined, to be the test of its existence, is either the mere substitution of words for words, or an attempt to make that mere substitution effect something more than lies in it to perform.

The conditions of a good definition are: 1, perfect axiomatic evidence that the property which is made the distinguishing test belongs to the object intended to be defined, and to nothing else; 2, entire separation of the part of the property, if any, which admits of being demonstrably connected with the notion defined, from that which contains the assumption; 3, the introduction of the definition in the proper place, namely, when the necessity for a new verbal representation has begun to appear.

The mere verbal definition is not to be regarded as taking for granted the existence of the thing defined. When Euclid defines *parallel lines*, he does not require consent to the proposition that parallels exist. All he is to be taken as asking is this: If there be two straight lines which being in one plane never meet, let them be called —*parallels*.

DEFLAGRATION is a term employed to denote the sparkling combustion of substances without violent explosion: thus when nitre and sulphuret of antimony are mixed and ignited or thrown into a hot crucible, the combustion which occurs is of the kind termed deflagration.

DEFLECTION. A term applied to the distance by which a curve departs from another curve, or from a straight line; and also to any effect either of curvature or of discontinuous change of direction. It is used where any "bending off" takes place, which is in fact the etymological meaning of the word.

DEGREE. [Arts; Universities.]

DEGREE OF ANGULAR MEASURE. [Angle.]

DEGREE OF AN EQUATION. The degree of an algebraical term is the number of letters which enter into it as factors. Thus x^2y^3 is absolutely of the fifth degree; but of the second degree with respect to x, and of the third with respect to y. The degree of an equation is the degree of its highest term.

DEGREE OF LATITUDE, OF LONGITUDE, OF MERIDIAN, &c. [Geodesy.]

DEIFICATION. [Apotheosis; Consecration.]

DEISM properly means belief in the existence of a God, but is generally applied to all such belief as goes no farther, that is to say, to disbelief of revelation. It is always applied dyslogistically, and frequently merely as a term of reproach. But the identical word, in its Greek form, *theist*, is not a word of disapprobation, and, consistently with established usage, may be appropriately applied as opposed to atheist, when the latter term is correctly used. For it must be observed that the term atheist has been not unfrequently employed in the sense of an unbeliever in Christianity, though at the same time professing theism.

DEL CREDERE COMMISSION. [Agent.]

DELEGATES, THE COURT OF, was formerly the great court of appeal in ecclesiastical causes, and from the decisions of the Admiralty Court. It was so called because the judges had delegated to them by commission under the great seal the appellate jurisdiction of the crown in these matters. These delegates usually consisted of judges of the courts at Westminster and doctors of the civil law, but lords spiritual and temporal might be joined. This court was first created, in consequence of the statute 25 Henry VIII., c. 19, which transferred to the crown the authority of the pope to entertain appeals from the courts Christian.

By the constitutions made at Clarendon, 11 Henry II., the practice of appealing to the pope had been condemned; but though frequently checked, it was never thoroughly broken off until the final rupture with the court of Rome, in the reign of Henry VIII. After sentence by the delegates, the crown might grant a commission of review; but the power was rarely exercised, except upon the ground of error in fact or in law, and it was usual to refer the memorial praying for a commission of review to the chancellor, before whom the expediency of granting the prayer was argued.

By 2 & 3 Wm. IV. c. 92, the Court of Delegates was abolished, and its powers and functions were transferred to the crown in council [Privy Council]. The same statute enacted, that no commission of review should in future be granted. This jurisdiction is now exercised by the Judicial Committee (3 & 4 Wm. IV. c. 41).

DELIAN PROBLEM. [Duplication.]

DELIQUESCENCE, the change of form which certain bodies undergo from solid to fluid by exposure to the air, and absorbing moisture from it.

There are many substances which partake of this property: among the more remarkable are potash, carbonate of potash, chloride of calcium, and nitrate of copper; all these will in a short time attract sufficient water from the air to become fluid in it. Other saline bodies are deliquescent only in moist air, such as chloride of ammonium and nitrate of ammonia.

Certain deliquescent salts, and more especially chloride of calcium, are employed for the purpose of drying gaseous bodies which are the subject of experiment.

DELIRIUM TREMENS, a disease of the nervous system, to which persons addicted to alcoholic drinks, though not exclusively, are peculiarly liable. As its name indicates, its principal symptoms are delirium and trembling. The delirium is a constant symptom; but the tremor is not always apparent, or does not exist. The delirium is always attended with sleeplessness: the patient is busy, and constantly talking, but is seldom or ever angry or violent. If he is questioned, he answers rationally, but speaks in an agitated and suspicious manner; he mostly does whatever he is told, and is frequently anxious to oblige. His thoughts, however, wander very quickly from objects around him, and he is apparently surrounded by the scenes of his imagination. Here, according to his occupation, he is busily engaged. If he is a master, he will order; if a servant, he will be anxiously obeying his master's commands. The sailor, the soldier, the coachman, all get busily engaged in their occupations. His thoughts are mostly distressful and anxious; he fancies he is in debt, that persons are persecuting him, that reptiles or animals are running after him; he looks suspiciously behind the curtains or door, or under the pillow, and wants to wander about. He seldom meditates harm either to himself or others. When there is tremor, the hands are fidgetty and the patient constantly wants to use them. In addition to these symptoms are others less observed; the tongue is moist and creamy, the pulse though frequent is soft; the skin is perspiring, and emits a peculiar odour.

The disease with which this may be confounded is inflammation of the brain; and it is of the greatest importance that it should be distinguished, as the remedies that cure in the one disease will destroy in the other. Although delirium tremens does not invariably present itself in the drunkard, yet, when a person who drinks much alcohol presents many of the above symptoms, there is strong ground for believing it to be delirium tremens.

When the symptoms of this disease are obvious, its treatment is simple. The patient must have a sufficient quantity of opium administered to him to procure sleep; it should first be commenced in small doses, and then continued. A third of a grain of morphia may be given every two hours to begin with, and this may be increased to one or more grains. Generally, after a first sleep the patient becomes refreshed, and not unfrequently wakes up entirely well. Sometimes opium alone is not sufficient; this is the case where the disease has come on as the consequence of a cessation of an accustomed stimulus; in these cases it will frequently be necessary to let the patient have his ordinary beverage in order to prevent that degree of exhaustion which appears to keep up the irritability of the system. This remedy ought not, however, to be continued after the patient has acquired sufficient strength to do without it. Chloroform has been recommended as a means of procuring sleep when opium fails.

When the disease is about to terminate fatally, the delirium abates, and coma takes its place; the tremor of the limbs becomes subsultus tendinum, the evacuations are passed involuntarily, the face becomes suffused, and the patient dies as though he were in apoplexy. The attacks of delirium tremens are very apt to recur, especially in drunkards who do not after their first attack give up the vice to which they are addicted. First attacks seldom prove fatal, but subsequent attacks are not uncommonly attended with fatal symptoms. After death from delirium tremens, the ventricles of the brain are usually found effused with serum. Serum, and even lymph, is also found occasionally under the arachnoid.

(Watson, *Lectures on the Practice of Physic;* Marshall Hall, *Diseases of the Nervous System.*)

DELIVERY. [DEED.]

DELIVERY ORDER. [DOCK WARRANTS.]

DELPHINE ($C_{27}H_{19}NO_2$?). An alkaloid, not yet thoroughly investigated, found in the seeds of the *Delphinium Staphisagria*, along with a yellow solid non-crystalline body, *staphisain* ($C_{32}H_{23}NO_4$). Delphine is a light yellow resinous solid, which fuses at 248° Fahr., and volatilises with the vapour of water.

DELPHINIC ACID. [VALERIANIC ACID.]

DELPHINUS (the Dolphin), one of the old Greek constellations, referred to the fable of Amphitrite and to that of Arion. It succeeds Aquila in the heavens, and its principal cluster comes on the meridian about three-quarters of an hour later than the principal star (α) of the latter, and nearly in the same declination.

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
ε	2	7088	4
β	6	7121	4
α	9	7149	3·5
δ	11	7173	4
γ	12	7200	4

DEMAND AND SUPPLY are terms used in political economy to express the relations between consumption and production—between the demand of purchasers and the supply of commodities by those who have them to sell. The relations between the demand for an article and its supply determine its price or exchangeable value [VALUE]: the relations between the demand for labour and its supply determine the amount of wages to be earned by the labourer [WAGES]. For causes explained elsewhere, the price of an article will rarely vary, for any length of time, very much above or below its cost of production;* nor will the wages of labour, for any length of time, much exceed or fall below the amount necessary to maintain labourers and their families in such comforts as their habits of life have accustomed them to believe necessary for their subsistence; but bearing in mind that, in the prices of commodities and labour, there is a certain point, determined by causes independent of demand or supply, above or below which prices cannot materially vary for any considerable time, all variations of price, if the medium in which they are calculated remains unchanged, may be referred to the proportion which exists between the demand for commodities and the supply of them—between the quantities which purchasers are willing and able to buy, and the quantities which producers are able and willing to sell.

To have any influence upon prices, a demand must be accompanied by the means of purchasing. A demand is not simply a want—a desire to obtain and enjoy the products of other men's labour; for if this were its meaning, there would never be the least proportion between demand and supply: all men would always want everything, and production could not keep pace with consumption. But an "effective demand," as it is termed by Adam Smith, exists wherever one man is anxious to exchange the products of his own labour for that of other men. It is, therefore, of an effective demand only that political economists are speaking when they examine the circumstances of demand and supply in connection with prices.

But although a demand, without the means of purchase, cannot affect prices, the universal desire of mankind to possess articles of comfort and luxury suggests other important considerations. As this desire is natural to man, and too often is so strong as to tempt him even to commit crime, it obviously needs no encouragement: men will always gratify it whenever they have the means, and these means consist in the products of their own labour. Hence all that is required to convert this desire of acquisition into an effective demand is ample employment for industry. Increase the production of all commodities and an increased consumption of them is the certain result; for, men having larger products of their own labour to offer in exchange for the products of other men's labour, are enabled to purchase what they are always eager to acquire. Production, therefore, is the great object to be secured, not only as furnishing a supply of commodities necessary and useful to mankind, but also as creating an effective demand for them. When trade is depressed by a languid demand, it is commonly said that increased consumption is all that is required to restore its prosperity. But how is this consumption to be caused? The desire to consume is invariable, and thus any falling off in consumption must be attributed to a diminished production in some departments of industry which causes an inability to consume. When production is restored, an effective demand for all articles will immediately follow; but until the productive energies of the consumers are in a state of activity it is in vain to expect from them an increased demand.

These considerations lead us to the conclusion that a universal glut of all commodities is impossible. The supply of particular commodities may easily exceed the demand for them, and very often does exceed it; but as the constant desire to obtain commodities needs nothing but the power of offering other commodities in exchange, to become an effective demand, it is evident that a universal increase of production is necessarily accompanied by a proportionate increase of consumption. Men are stimulated by no love of production for its own sake, but they produce in order to consume directly, or because by exchanging their produce with others they are able to enjoy the various comforts and luxuries which they are all desirous of obtaining. Active production, therefore, in all departments of industry causes a general and effective demand for commodities, which will continue to be equal to the supply unless it be checked by war, by restrictions upon commerce, or by other circumstances which prevent a free interchange of commodities.

A country is in the highest prosperity when there is an active and steady demand for commodities and labour, and a sufficient supply of them. Any disturbance of the proportion between one and the other is injurious to the community; and the injury is greater or less according to the extent and duration of such disturbance. When the proportion is well adjusted, the whole community derive benefit from the circumstance, both as producers and consumers; when it is disturbed, they are injured in both capacities.

Having described thus generally the nature and causes of demand, and its intimate connection with supply, it becomes necessary to examine the influence of demand and supply upon one another, and upon production, consumption, prices, and profits. This influence varies according to the circumstances of the market, and the nature of the commodities to which its laws may be applied. These may be best understood by considering, 1st, the effects of a demand exceeding the supply; and 2ndly, of a supply exceeding the demand.

I. The first effect of a demand exceeding the supply of a commodity is to raise its price. As more persons want to buy the commodity than the producers are able or willing to supply, they cannot all obtain what they desire, but must share the supply between them in some manner. But their wants are very much regulated by the cost of gratifying them. One man would purchase an article for a shilling for which he may be unwilling or unable to pay two; while others, rather than forego the purchase, will consent to pay that amount. Those who have commodities to sell, finding that they have more customers than they can satisfy, immediately infer that they are selling them too cheaply, and that they could dispose of all their stock at a higher price. The price is accordingly raised, when the sale becomes limited to those who are not restrained from buying by the increased price. In principle, though not in outward form, the market is in the nature of an auction.

---

* "Cost of production" is used by political economists in a sense different from that of commerce, and includes profits. (See M'Culloch's edition of Adam Smith, c. 7.) It means, in fact, the price below which no man would continue to sell his goods. An ordinary profit is a part of the cost of production in an enlarged sense, as much as the expense of wages and materials.

The sellers endeavour to obtain the highest price for their goods; the price rises with the eagerness of those who wish to buy, and the highest bidders only secure the prizes. In the market, however, the competition of the buyers is not perceptible amongst themselves except through the prices demanded. Their competition determines the prices, but the sellers judge of its extent and regulate their demands so as to obtain the greatest possible advantage from it.

Some commodities are positively necessary for the support of the people, of which the supply may fall very short of the demand and be incapable of increase. This is the case when there is a bad harvest in a country which is excluded from a foreign supply by war or by fiscal restrictions. Here the price rises in proportion to the deficiency of the crops. The competition for food is universal. Some, indeed, may be driven to the consumption of inferior articles of food, and others to a diminished consumption; but all must eat. The number of consumers is not diminished, while the supply is reduced; and the price must, therefore, rise and continue high until a fresh supply can be obtained. In a siege the competition is still greater: the prices of provisions become enormous; the rich alone can buy, the poor must starve or plunder.

A similar effect is produced if the supply, without being deficient, be confined to the possession of a small number of persons, who limit it to the consumers in order to secure higher prices. However abundant corn might be in a besieged town, if one man were exclusively authorised by law to sell it, it might rise to a famine price, unless the people broke into the granaries, or the government interfered with the monopoly. Less in degree, but similar in principle, is the effect upon prices of every limitation of the market by fiscal restrictions. When any sellers are excluded, the others are enabled to raise their prices.

These are cases in which the supply cannot be increased to meet the demand, or in which the supply is monopolised. But the greater number of commodities may be increased in quantity, and the supply of them is not artificially limited. The price of these also rises when the demand exceeds the supply; but the increased price raises the profit of the producer and attracts the competition of others in the market. Fresh capital and labour are applied to the production of the profitable article, until the supply is accommodated to the demand, or exceeds it. The prices gradually fall, and at length the profits are reduced to the same level as the profits in other undertakings, or even lower. The encouragement to further production is thus withdrawn, and prices are adjusted so as to secure to the producers the ordinary rate of profits, and no more.

But sometimes the demand for a commodity is diminished, if the supply fall short of it for any considerable time. There are various articles useful and agreeable to mankind, but not essential to their existence, which they are eager to enjoy as far as they can, but for which they are not prepared to make great sacrifices. When the price of an article of this description is raised by a deficient supply, continuing for some length of time, it is placed beyond the reach of many persons, who learn to regard it with indifference. They would buy it if it were cheap; but as it is dear they go without it, or are satisfied with a substitute. In this manner the number of consumers is diminished. Others again, who will not be deprived of an accustomed luxury, enjoy it more sparingly, and consume it in less quantities. But so long as the supply is not increased, the price will continue high, because the consumers who still purchase the article, notwithstanding its price, keep up an effective demand equal to the whole supply; while there is still a dormant demand, only awaiting a reduction of price to become effective.

For the same reasons, a demand for articles is diminished when their price is artificially raised by taxation. The demand is gradually confined to a smaller number of persons, and many consume more sparingly. [Tax; Taxation.]

In these various ways demand and supply become adjusted through the medium of price, whenever the one exceeds the other. This is the result of natural laws, the operation of which is of the highest value to mankind. If the supply be incapable of increase, it economises consumption; if the supply can be increased, it encourages production. In either case it is of great benefit to the consumer. To revert, for a moment, to the example of a bad harvest in a country excluded from all foreign supply. Suppose that prices did not rise, but remained precisely the same as if the harvest had been abundant, what would be the consequence? The whole population would consume as much bread as usual, and use flour in every way that luxury points out, unconscious of any scarcity. Farmers might even feed their cattle with wheat. By reason of this improvidence, the whole of the corn would be consumed before the next harvest, and the horrors of famine would burst, without any warning, upon a people living as if they were in the midst of plenty. This evil is prevented by a rise of prices, which is a symptom of scarcity, just as pain is a symptom of disease. By timely precaution the danger is averted. A high price renders economy and providence compulsory, and thus limits consumption. The supply, therefore, instead of being exhausted before the next harvest, is spread over the whole year. In the case of food, it is true that such economy is painful, and presses heavily upon the poor; but this evil is a mercy compared with famine. If no privation had been endured before scarcity became alarming, none but rich men could buy a loaf; for every one who had a loaf to sell would be risking his own life if he sold it.

These observations are also applicable in some measure to cases in which prices are raised by the supply being confined to one or to a few persons, who have contrived to buy up the whole or nearly the whole of any commodity. But such exclusive possession (sometimes improperly called a monopoly) cannot exist for any length of time in articles of which the supply is capable of increase. The extreme case has been put of a besieged town in which the whole supply of corn was monopolised by one man. Under those circumstances, of course he would demand a high price; but unless his exclusive supply were upheld by law, it does not follow that the inhabitants would suffer on that account. A most provident consumption of food is absolutely necessary for the defence of a town, and no organisation could distribute provisions according to the wants of the people so well as a system of purchase restrained by a high price. It must also be recollected that, without any such exclusive possession, the fact of the siege alone must raise prices by cutting off fresh supplies. If the siege continue, provisions are more likely to last out by the instrumentality of prices than by any other means. At the same time the sole possessor of the corn would be restrained from keeping back the supply beyond the actual necessity of the occasion by many considerations. He would know that if a popular tumult arose, if the town were relieved, the siege raised, a capitulation agreed to, or the place suddenly carried by assault, the value of his exclusive property would be destroyed. His own interest, therefore, is coincident with that of the people. It is better for both that the supply should be meted out with parsimony; it is dangerous to both that it should be immoderately stinted.

In circumstances less peculiar than these, very little evil can arise from an exclusive possession of any commodity not protected directly or indirectly by law. If the supply be capable of increase, and the demand be sufficient to enable the owner to secure a high price, for reasons already explained, the market would rapidly be supplied from other quarters. If the supply cannot be increased, that fact alone would raise the price; and it is probable that the supply would not have been so great without the extraordinary activity of the capitalist, who had been able to secure for his country the whole accessible supply to be collected from the markets of the world.

A monopoly, properly so called, is of a totally different character; for however abundant the supply of an article may be, it may, nevertheless, be inaccessible to the consumer. [Monopoly.] Such monopolies were properly condemned so far back as the reign of James I. (21 James I. c. 3), although vast monopolies are still indirectly maintained by our fiscal laws. [Tax; Taxation.] The legislature of this country, however, did not observe any distinction between a legal monopoly and the great speculative enterprises of commerce, miscalled monopolies; and severe penalties were inflicted, both by the common and statute laws, against offences called "badgering, forestalling, regrating, and engrossing." The impolicy of such laws was gradually perceived. If prices were occasionally raised by speculations of this kind, yet the restraints upon commerce, which resulted from these laws, were infinitely more injurious to the consumer. Many of the statutes were therefore repealed by Act 12 Geo. III. c. 71; but the common law, and all the statutes relating to the offences of forestalling, regrating, and engrossing, were not erased from our commercial code until the year 1844 (Act 7 & 8 Vict. c. 24).

When prices are high by reason of the demand exceeding the supply, it is by no means necessary that the profits of those who sell the dear commodities should always be greater than the profits in other branches of trade. It must always be recollected, that where scarcity is the cause of high price, the sellers who demand it have the less to sell. Where scarcity is not the cause, but the demand is great because the supply, notwithstanding the exertions of the producers, cannot keep pace with it, the profits are undoubtedly greater than usual, until the supply has been increased.

II. It is now time to consider the effects of a supply exceeding the demand; and this division of the inquiry will require less elucidation, as the effects of such a condition of the market may be stated to be the very reverse of those which we have just been examining. When there is more of a commodity than people are prepared to buy, its price must fall. Its sellers must offer it for sale at the price at which they can induce people to purchase. All is now in favour of consumers. They are no longer bidding against each other: but the sellers are competing among themselves to get rid of their goods. The price falls generally in proportion to the excess of the quantity, but this result is very much qualified by the nature of the article. If there be an excess of supply in perishable goods, there is nothing to prevent the natural fall of prices. When fish is unusually abundant, it must be cheap, or a great part of it will be destroyed: it must be eaten at once, or not at all; and to induce people to eat it, it must be offered to them at a low price. But with articles which may be held back, in expectation of higher prices, their value may be partially sustained. Production may be reduced, and the stock gradually brought into the market, until the supply has been equalised with the demand; and wherever the article is such as to admit of voluntary increase or diminution, the natural result of an excessive supply is to reduce production, until the balance of supply and demand has been restored. This mutual adjustment is in perpetual operation, and is ordinarily effected with such precision, that it may be said, without exaggeration, that a large city is supplied exactly with everything its inhabitants require—even down to an egg or a pint of milk. There is always enough of everything, and rarely too much.

Whenever there is an excessive production of any commodity, it is an evil almost as great as scarcity. It is true that the consumer derives benefit from it, but the producing classes are most injuriously affected. In order to raise the value of the produce of their labour, they must cease to produce, or must produce in less quantities. The workmen are thus either deprived of employment altogether for a time, or are employed for a portion of their time only, at reduced wages; while their employers are disposing of their goods at low prices, which scarcely repay the outlay of their capital. Nor does the penalty of over-production fall exclusively upon those engaged in the trade in which supply has exceeded the demand. Their distresses extend to other classes. It has been shown already that it is to production we must look as the cause of sustained consumption, and thus the pressure upon any considerable branch of productive industry must be sensibly felt by those who have the produce of their own labour to sell. Production has failed, and consumption must therefore be diminished.

The ruinous consequences of gluts, in particular staples of trade and manufacture, are too well known, especially in this country, to require any further illustration; but their causes are not always agreed upon. Such gluts are often attributed to the facility with which manufactures are produced by machinery; but we have shown that over-production in all branches of industry is impossible, and if that be true, it is evident that when partial gluts are produced by the aid of machinery, that powerful agent must have been misapplied. It is not contended that nothing can be produced in too great abundance. Whether machinery be used or not, production must be governed by the same laws of demand and supply. Those things only must be produced for which there is a demand, and they must not be produced in greater abundance than the demand warrants. But the more generally machinery is used, the more abundant will be the products which men will have to exchange with each other, and therefore the better will be the market. It follows that machinery can only cause a glut when applied excessively to particular objects, precisely in the same manner as an excessive quantity of labour would cause one if applied where it was not needed by the demands of commerce.

The supply of markets is a very speculative business, and is often conducted with more zeal than discretion. When a particular trade is supposed to be more prosperous than others, capitalists rush into it in order to secure high profits; and in this country the abundance of capital, the perfection of our machinery, and the skill of our workmen, enable them to produce with extraordinary facility. Over-production in that particular trade is the consequence, and all engaged in it suffer from the depreciation in the value of their goods; but if, instead of rushing into the favourite trade, they had distributed their enterprises more widely, their own interest and that of the community would have been promoted. When a ship is wrecked, if all the crew precipitate themselves into one boat, they swamp it; but if they wait till all the boats are lowered, and apportion their numbers to the size of each, they may all reach the shore in safety. And so it is in trade: one trade may easily be glutted, while there is room in other trades for all the capital and industry that need employment.

In proportion to the extent of the market and the variety and abundance of commodities to be exchanged, will be the facility of disposing of the products of capital and labour; and this consideration points out as the most probable antidote to gluts a universal freedom of commerce. When the free interchange of commodities is restricted, not only is a glut caused more easily, but its causes are more uncertain, and dependent upon unforeseen events. With the whole world for a market, the operation of the laws of demand and supply would be more equable, and the universality of the objects of exchange would make gluts of rare occurrence. The market would still be liable to disturbance by bad harvests, by errors in the monetary system, by shocks to public credit, and by war; but apart from these causes of derangement, demand and supply would be adjusted, and the productive energies of all nations called into full activity.

(Adam Smith, *Wealth of Nations*, book i.; M'Culloch, *Principles of Political Economy*, part i. ch. 7, and part ii. ch. 1, 2; Malthus, *Principles of Political Economy;* Ricardo, ch. 30; Mill, *Essays on Unsettled Questions of Political Economy*, Essay ii.)

DEMESNE. [MANOR.]

DEMETER (Δημήτηρ), one of the twelve principal deities of the Olympus of the Greeks: by the Romans she was called Ceres. Demeter was the great mother-goddess, the giver of the fruits of the earth, the nourishing and fertilising principle of nature.

In the Greek mythology Demeter was the daughter of Kronos and Rhea. By her brother Zeus she was the mother of Persephone (often only called Cora, Κόρη, the maiden, the Proserpine of the Romans), and also according to Hesiod (Theog. 452, &c.), of Dionysus (Bacchus); but the more prevalent notion was, that Dionysus was the son of Semele. It is certain, however, that Demeter is in various ways closely associated with Dionysus, and their rites, the Dionysian and Eleusinian mysteries particularly, as will be noticed further below, are intimately blended. By later writers, Demeter is sometimes alluded to as the wife of Dionysus.

The leading feature in the story of Demeter, and that which forms the fundamental idea of her worship, is the loss and recovery of her daughter, Persephone, who was suddenly seized and carried off to the infernal regions by Pluto [PERSEPHONE]. Demeter, who heard her cries, but did not see who had carried her away, nor know whither she had gone, sought in vain for her over the earth, till she applied to Helios. Having learned from him that Zeus had, without consulting her, given Persephone to Pluto as his wife, and that she had been carried off to Erebus, Demeter in her anger vowed not to return without her to Olympus. Zeus sent first Iris, and then all the gods to invite her to return, but in vain; when fearing lest the human race should perish, she having afflicted the earth with sterility, he despatched Hermes to Erebus to bring back Persephone. Pluto did not offer to resist the will of Zeus, but he gave Persephone a pomegranate, and she having eaten of the food of Erebus was thenceforth compelled to spend a portion of every year in the infernal regions. Hermes conducted Persephone to her mother at Eleusis, and Zeus sent Rhea to again urge Demeter to revisit Olympus, informing her that he had consented that Persephone should remain with her mother two-thirds of the year, the other third (the season of winter) being spent with Pluto. Demeter now consented to return, and to restore fertility to the earth. But before departing from Eleusis, which she had made her abode, she taught Triptolemus the manner in which her worship was to be conducted, and instructed him in the mysteries of the Eleusinia. [ELEUSINIA.]

Demeter was the oldest, and with a view to the formation of a systematic mythology, the most important personage in the Greek polytheism. Her name Demeter (γῆ, *earth*, μήτηρ, *mother*), or Deo, points to her as a representative of the earth and its productions in the old elementary worship of Greece; and she is invoked by Orpheus (apud Diod. Sic. i. 12) as Mother Earth, the giver of all sorts of riches (γῆ μήτηρ πάντων Δημήτηρ πλουτοδότειρα). The title Father is in the same manner given to the air by Lucretius (i. 25),

> Postremo percunt imbres ubi eos *pater Æther*
> In gremium *matris Terrai* præcipitavit;

and the Greeks considered all vegetable productions as the offspring of a union between these two elements. (See the fragment of the Danaides of Æschylus in Hermann's 'Opuscula,' vol. ii., p. 334.) The mystic union of these two principles, from which all the other deities sprung up, is an invention of the later philosophers. A remarkable feature which the worship of this deity presents in Greek mythology is her intimate connection with Dionysus, a connection which seems to have belonged to all the different modifications of the two worships. At Eleusis these two deities were worshipped with peculiar solemnities. [DIONYSIA, ELEUSINIA.] It does not seem right to infer from the similar relation subsisting between Osiris and Isis in Egypt, and Dionysus and Demeter in Greece (Macrob., 'Saturnal.,' i. 2, p. 210; Herod. ii. 144; Plutarch 'de Iside,' p. 354 F.), that the worship of these deities was derived from Egypt in particular, though, as will be seen by the engraving below, Demeter was sometimes represented by the ancient sculptors with some of the attributes of Isis. Still less, however, can we adopt Creuzer's theory of the Indian origin of this religion. It seems more reasonable to conclude that the same causes which might contribute to produce such an elementary worship in the East would have the same effect in Greece; for the constitution of the human mind is much the same in all parts of the world.

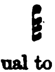
A collection of the names and epithets of Demeter is given by Creuzer ('Symbolik,' vol. iv., p. 301, fol.), but his remarks must be read with some caution, as he shows a curious readiness to identify her with other deities. The meaning of her Roman name, Ceres, by which Demeter is generally mentioned in English books on mythology, is not known; it may be derived from *c(e)reare*, *creare*, to produce (Creuzer, 'Symbolik,' iv., p. 313); or it is connected with her Cabiric name, Axiokersa, in which case it also signifies the producer; for according to Hesych., κέρσαι = γαμῆσαι, κέρσης = γάμος and μίξαι = κέρσαι.

Demeter is represented in ancient monuments with a basket (κάλαθος), or a crown of ears of corn on her head, with some ears of corn and poppies in her right hand, and a torch, or occasionally a sceptre, in her left hand, and sometimes as seated in a chariot drawn by lions, panthers, elephants, or dragons. (Winckelmann's Works, vol. ii. 515, iv. 119.) Her form is that of a beautiful matronly woman, with a mild and benevolent expression of face. She is always enveloped with ample drapery, which is usually close up to the neck; but sometimes one of her teeming breasts is uncovered. Demeter is frequently seen enthroned, or seated with her daughter Persephone alongside of her; the figure of Persephone being much slighter and less matronly than that of her mother. Two very beautiful figures on low seats, from the Western pediment of the Parthenon at Athens, and now in the British Museum, are believed to represent Demeter and Persephone, but both the figures have lost their heads, and their distinguishing attributes. A fine statue of the Græco-Roman period, in the same collection (from the Macarani Palace at Rome), of which we give a cut, represents the goddess with some of the attributes of Isis, but the head appears to have belonged to another statue of Ceres. It is in the head that the Egyptian character is discernible. On it is an Egyptian diadem, in front of which is a disc between two serpents, and surmounted with ears of corn. She wears a long tunic and pallium; and holds in her left hand a *situla*, or sacred bucket, and wreaths of flowers; the right hand is a modern restoration. Demeter is sometimes represented (especially on gems and vases) as an enraged deity, with torch in hand and flying drapery searching after the lost Persephone. Sometimes, again, escorting her daughter on her annual journey to or from Erebus. Among other of the less familiar events in her story, which appear to have often engaged the skill of the Greek sculptors and vase-painters, was her connection with the mystic Iacchus, who is represented sometimes as a child at her breast, sometimes as a boy beside her. A colossal bust crowned with a basket, which is believed to have been a portion of the great statue of Demeter, was, in 1801, brought from the site of the chief temple of the goddess on the Acropolis of Eleusis, and deposited in the public library of Cambridge University; but it has been by some supposed to have rather formed a portion of a canephorus or cistophorus. The great temple of Demeter at Eleusis was the largest in all Greece, and was designed by Ictinus, the architect of the Parthenon. Very little is now left of it; its area forming the centre of the modern village. [ELEUSIS, in GEOG. DIV.]

[Demeter, from the British Museum.]

DEMI-LUNE. [RAVELIN.]

DEMISEMIQUAVER, a musical character, formed by adding three hooks to the stem of a crotchet, Ex.—



and in length, or duration, is equal to $\frac{1}{32}$ of a semibreve. [SEMIBREVE.]

DEMOCRACY (*δημοκρατία*) a word taken from the Greek language, like aristocracy, oligarchy, monarchy, and other political terms.

The third book of Herodotus (chap. 80–82) contains what we may consider as the views of the oldest extant Greek historian on the merits and defects of the three respective forms of government as they are called, democracy, oligarchy, and monarchy. It would be difficult to extract from the chapters referred to an exact definition of democracy, but still we learn from them what were considered to be essentials; first, complete political equality (*ἰσονομίη*); secondly, the election of magistrates by lot (*πάλῳ*) (which, coupled with the first condition, implies that public offices must be accessible to all); thirdly, responsibility or accountability in public functionaries (*ἀρχὴ ὑπεύθυνος*), which implies a short term of office and liability to be ejected from it; fourthly, the decision by the community at large of all public matters (*τὸ βουλεύματα πάντα ἐς τὸ κοινὸν ἀναφέρειν*).

It is unnecessary to mention the merits and defects of a democracy as pointed out in the above chapters, the defects being only certain consequences supposed to flow from, and the merits certain advantages incident to, a democratical institution, and neither being essentially parts of the fundamental notion of a democracy.

In forming a notion of a democracy as conceived by the Greeks, and indeed in forming any exact notion of a pure democracy, it is necessary to consider a small community, such as a single town with a little territory, and to view such a community as an independent sovereignty. The institutions which in modern times have approached most nearly to the form of a pure democracy are some of the Swiss cantons. The boroughs of England, as existing in their supposed original purity, and as partly restored to that supposed original purity, by the Municipal Corporation Act, may help to explain the notion of a democracy, though they are wanting in the necessary element of possessing sovereignty. Further, to conceive correctly of a Greek democracy and of some of the democracies of the North American Union, it must be remembered that the whole community in such States consisted and consists of two great divisions, freemen and slaves, of whom the latter form no part of the political system.

In most Greek communities we find two marked divisions of the freemen, the "few" (*ὀλίγοι*) or "rich" (*δυνατοί, πλούσιοι*), and the "many" (*οἱ πολλοί, ὁ δῆμος*) or "not rich" (*ἄποροι*), between whom a fierce contest for political superiority was maintained. This contest would often end in the expulsion of the "few," and the division of their lands and property among the "many;" sometimes in the expulsion of the leaders of the "many," and the political subjugation of the rest. Thus the same state would at one time be called a democracy, at another an oligarchy, according as one or the other party possessed the political superiority; a circumstance which evidently tended to confuse all exact notions of the meaning of the respective terms used to denote the respective kinds of polities. Under the circumstances described, what was called an oligarchy might perhaps be appropriately so called; what was called a democracy was not appropriately so called, even according to the notions entertained by the Greeks themselves of a democracy; for such so-called democracy was only a fraction of the community that had obtained a victory over another fraction of the community, less numerous and individually more wealthy: for the "few" and the "rich" were necessarily united in idea; it being, as Aristotle remarks, incident to the "rich" to be the "few," and the rest to be the "many."

Aristotle felt the difficulty of defining what a democracy is. He observes ('Politik.' iv. 4) that neither an oligarchy nor a democracy must be defined simply with reference to the number of those composing the respective bodies: if a considerable majority, he says, are rich, and exclude the remaining body of freemen, who are poor, from political rights, this is not a democracy. Nor, on the contrary, if the poor, being few, should exclude the rich, being more numerous, from all political power, would this be an oligarchy. Indeed such a supposition as the latter is impossible in a sovereign community, except during a short period of revolutionary change.

Aristotle, after some preliminary remarks, concludes by defining a democracy to be, when the freemen and those not the rich, being the majority possess the sovereign power; and an oligarchy, when the rich and those of noble birth, being few, are in possession of the sovereign power. This definition of an oligarchy necessarily implies that the majority are excluded from participating in the sovereign power. It might be inferred, on the other hand, that in this definition of a democracy the few are excluded from the sovereign power; and such in this passage should be the meaning of the author, if he is consistent with himself. In another passage (iv. 4), where he is speaking of the different kinds of democracy, he speaks of the first kind as characterised by *equality* (*κατὰ τὸ ἴσον*): and by this equality he understands "the not rich having no more political power than the rich, neither body being supreme, but both equal, and all participating equally in political power." Such in fact approached very near the exact notion of a pure democracy, or at least a democracy as pure as we have any example of; for women, persons of unsound mind, males not adult, and slaves, are excluded from political power even in democracies.

A pure democracy, then, is where every male citizen, with the exceptions above mentioned, forms an equal and integral part of the sovereign body; or, as Aristotle expresses it, the democracy is "monarch, one compounded of many." This is the fundamental notion of a democracy: every other institution incident to or existing in a democracy, is either a necessary consequence from this notion or a positive law enacted by the universal sovereign.

If the democracy consider a constitution [CONSTITUTION] to be useful for carrying into effect the will of the sovereign, such constitution, when made by the expressed will of the majority, whatever may be the terms of such constitution, does not affect the principle of the democracy. Such constitution can be altered or destroyed by the same power that made it. If a representative body is necessary for effecting the purposes of the sovereign, such body may be elected and invested with any powers by the sovereign body, always provided that the representative body is responsible to the sovereign whose creature it is. Whatever institutions are created, and whatever powers are delegated by the sovereign many, the principle of pure democracy still exists so long as every individual and every body of individuals who exercise delegated power are responsible to the sovereign body by whom the power is delegated. Hence if property be made a qualification for certain offices, as in one of the forms of democracy mentioned by Aristotle, by the universal sovereign, such requisite qualification does not in itself alter the nature of the democracy, being only a rule or law fixed by the sovereign. It is, however, a rule or law of that class, the *tendency* of which, where the sovereign power is possessed by the many, is to undermine and ultimately destroy the power that made it.

Experience has shown that even where the universal people are sovereign, if the political community is large and spread over a great surface, every delegation of power, however necessary, is accompanied with danger to the existence of the sovereign power. The more complicated the machinery of administration becomes, and the more numerous are the administering bodies interposed between the sovereign and the accomplishment of the object for which the sovereign delegates part of his power, the greater is the risk of those who have had power delegated to them making themselves the masters of those who have conferred the power. In a democracy the great problem must be to preserve unimpaired and undisputed the vital principle of the sovereign power being in all and in every individual, and to combine with this such a system of delegated powers as shall in their operation always recognise that principle to which they owe their existence.

Aristotle ('Pol.' iv. 5) well observes that a polity may not be democratic according to the laws, that is, the fundamental laws or constitution, but that by opinion and usage it may be administered democratically: in like manner a democratic constitution may come to be administered oligarchically; and he explains how this may come to pass.

It may happen that other persons besides those enumerated may be excluded from participation in the sovereign power in a government which is called a democracy. The suffrage may be given only to those who have a certain amount of property, which resembles one of the cases mentioned by Aristotle. If the amount of property required should exclude a great number of the people, the government might still be called democratical rather than by any other name, if the persons excluded were a small minority compared with the majority. If they were nearly equal in numbers to the majority, they would find out some name for the majority which would express their opinion of the form of government: and the word that they would now use would be aristocratical, a word which would imply dislike and censure. If the portion of the people who were thus excluded from the suffrage should be a majority, the ruling body would be properly called an aristocracy.

A democracy has been here defined as it has existed in some countries and as it exists in others. No attempt is made to ascertain its origin, any more than the origin of society. It is here viewed as a form of government that may and does exist. The foundation of the notion of a democracy is that the sovereign power is equally distributed, not among all the people in a state, but among all the freemen who have attained a certain age, which is defined. Democracy therefore, if we derive the notion of it from all democracies that have existed, instead of from certain wild theories of natural rights, is based upon the principle that it is for the general interest that some persons should be excluded from the possession of that political power which others enjoy. A democracy also like a monarchy can only give effect to its will through the medium of forms and agents. Practically there cannot always be a reference to the will of the majority on every occasion, no more than there can be in a monarchy. A monarch must govern by the aid of others, and the sovereign democracy must carry its purposes into effect by the aid of members of its body, to whom power sufficient for the purpose is given. The agent of a democracy is a representative body for the purpose of legislating. For the usual purposes of administration a democracy must have agents, officers, and functionaries, as well as a monarchy. The mode in which they are chosen and the tenure of office may be different, but while they act, they must have power delegated of a like kind to that which a monarch delegates. A form of government may be such that there shall be an hereditary head, a class with peculiar privileges, and also a representative body. The existence of a representative body chosen by a large class of the people, has led to the appellation of the term democratical to that portion of such governments which is composed of a representative body, and to those who elect such body. But the use of the terms democracy and democratical, as applied to such bodies, tends to cause confusion. It is true that such mixed governments present the spectacle of a struggle between the different members of the sovereign power, and as it is often assumed that the popular part aims at destroying the other parts, and as many speculators wish that it should ultimately destroy them, such speculators speak of such so-called democracy as a thing existing by itself, as if it were a distinct power in the state; whereas, according to the strict notion of sovereignty, there is no democracy except when there is no other power which participates in the sovereignty than individuals possessed of equal political power. When the popular member of a sovereign body has destroyed all the other members, the popular member becomes the sovereign body, and it is a democracy, if it then corresponds to the description that has been given of a democracy.

A curious article by M. Guizot, entitled 'Of Democracy in Modern Society,' has been translated and published in England. It is written with reference to the condition of France, and in opposition to the assertion made by some French writers "that modern society, our France, is democratical, entirely democratical; and that her institutions, her laws, her government, her administration, her politics, must all rest on this basis, be adapted to this condition." M. Guizot successfully combats certain hypotheses and assumptions, most of which however have either been exploded by all sound political writers or would be rejected by any man of reflection. His essay contains, as we might expect from his attainments and long experience in the world, many just remarks, but it is disfigured and often rendered almost unmeaning by the lax use of political terms and a tone of mysticism and obscurity which are better adapted to confuse than to convince.

In the third volume of 'Political Philosophy,' published in 1846, Lord Brougham has treated the subject at considerable length, and illustrated it with examples which fully support the views given above.

DEMOIVRE'S HYPOTHESIS. An hypothesis on the duration of human life, formed by Demoivre, as he informs us in the preface of his 'Treatise on Annuities,' some years after the publication of the first edition of his 'Treatise on Chances,' on the inspection of 'Halley's Breslau Tables.' Observing that the decrements of life at the middle ages were very nearly uniform, Demoivre made an extension of this law to the whole of life, not thereby intending to assert that any such principle was correct for childhood and old age, but simply that the effect of the error upon the value of annuities at the middle ages of life would be trivial. The hypothesis is as follows: *of eighty-six persons born, one dies every year, till all are extinct.* The remainder of eighty-six years, at every age, Demoivre called the *complement of life.* The half of the complement of life is the average duration (commonly called the expectation); and the peculiarity of Demoivre's hypothesis is, that, according to it, every person has an even chance of living the average time of people of his age, which is not true of other tables. The Northampton Tables certainly do nearly coincide with this law at the middle periods of life, but the Carlisle and most other tables differ materially from it. Thus at twenty years of age, according to the Carlisle Tables, the *average duration* is to the age of sixty-one and a half, while each individual aged twenty *has an even chance* of living to be about sixty-five years of age.

The following table (left hand) shows the number of persons out of ten thousand who may be expected to die in the year next following their attaining the age marked in the first column, according to this hypothesis, the Northampton and Carlisle Tables, and the Belgian Tables of M. Quetelet:—

Age.	Hypothesis.	Northampton.	Carlisle.	Belgian.
10	132	92	45	88
20	152	140	71	120
30	179	171	101	136
40	217	209	130	144
50	278	284	134	183
60	385	402	335	325
70	625	649	516	680
80	1667	1343	1217	1425

Age.	Hypothesis.	Northampton.	Carlisle.
10	19·9	20·7	23·5
20	18·5	18·6	21·7
30	16·8	16·9	19·6
40	14·8	14·8	17·1
50	12·5	12·4	14·3
60	9·7	9·8	10·5
70	6·4	6·7	7·1
80	2·3	3·8	4·4

The right hand table shows the values of annuities on lives of the ages in the first column, at three per cent., in years' purchase. Practically speaking, then, the celebrated Northampton Tables agree with Demoivre's hypothesis in their money results, though by no means exhibiting the same physical law of life.

It must be observed of Demoivre's hypothesis, that any one which supposes uniform decrements throughout is entitled to the name, whether the limit of life be eighty-six years or not. Conformably to this view, the modification which best represents the Carlisle Tables would be, that, of 128 persons born, one dies every year; a supposition which would be as much in excess on one side, for old lives, as that of eighty-six is in defect, but which would represent the Carlisle Tables from twenty to fifty years of age as well as the use of eighty-six does the Northampton Tables.

DEMOLITION of works, buildings, &c. The method to be employed in the destruction of works, buildings, bridges, &c., by gunpowder in war time, being so much dependent on the amount of labour and time which can be employed on it, and the fact that no certain rules have yet been arrived at for determining the proper charges for throwing down masonry, make the military engineer dependent on his own judgment, and a consideration of some of the examples of demolitions which have been successful, but at the same time render the subject too diffuse to be more than hinted at in such an article as the present; the reader being referred for details of the subject to the article 'Demolition,' by Gen. Sir H. D. Jones, R.E., in the 'R.E. Aide-Mémoire.' The works which a military engineer is principally called upon to destroy are, revetments, towers, magazines, military buildings, bridges, and barriers.

Revetments have been destroyed in a variety of ways, either by piercing the foot of the revetment from the ditch, or by sinking shafts at the back of the revetment, or by running galleries from the interior of the work to the back of the revetment, the employment of either of these means being dependent on the circumstances of the nature of the revetment, and of the soil of the rampart. In the destruction of the Spanish lines before Gibraltar in 1810, several attempts were made to run a gallery from the interior of the work to the back of the revetment, but the sand so constantly came in at the head of the gallery, that it at last brought down the terreplein, and eventually shafts had to be sunk at the back of the revetment, which is in general the commonest and easiest method of execution. When the shaft or gallery has been driven to the foot of the revetment, short returns are usually made to the right and left along the back of the revetment, and the charges either placed against or in the counterforts, or disregarding them, as at the destruction of the face of a bastion at Turin, which was successful at equal distances along the revetment. Gen. Sir Charles Pasley, in his tract on 'Military Mines,' gives $\frac{3}{20}$ LLR^3 [MINES], as the charge when placed at 2-lined intervals along the back of the revetment without counterforts, $\frac{1}{3}$ LLR^3, when in the middle of each counterfort at its junction with the revetment, and $\frac{1}{3}$ LLR^3 when in the centre of a line of masonry with counterforts at 2-line intervals, whilst $\frac{1}{10}$ LLR^3 is the charge when placed in the centre of a mass of masonry of a circular or polygonal base.

Towers are usually destroyed either by mining the base, as with revetments, or by placing the charge in the centre of basement on the floor, or distributing at the angles of the basement.

Magazines, if time will permit, are best destroyed by a series of mines placed in the centre of the thickness of its piers and of its gable; but they may be hastily destroyed by placing the powder in a heap on the floor, fastening the doors and windows, and firing by a hose from the outside.

Buildings may be destroyed by charges placed in the same way in the cellars or lower rooms, or by placing a series of small charges or blasts in the thickness of the wall of the basement between the windows, the holes being driven from the windows.

Various methods were adopted in the Peninsula war for destroying bridges, according to circumstances. It frequently happens whilst an army is before the enemy, and closely pressed by him, that a bridge is required to be destroyed to prevent his pursuing a retreating body, or to gain time for the movements of an army by arresting his progress. Sir H. Jones says in the article before mentioned, "In the retreat of the British army from Burgos, upwards of twenty bridges were destroyed, with the exception of two or three, which were only partially injured from want of time; the destruction of the others was perfect; in many cases the train was not lighted until the enemy were actually on the bridge; in others, as at Cabezon, the enemy's pickets were two or three days at one end of the bridge; an officer of engineers, during that time, waiting with a lighted slow match, prepared to fire the train the instant the enemy should attempt to push on to the bridge; at the same time cautioned not to be deceived by false alarm of his advance. In many instances an officer of engineers was unexpectedly called upon for the duty of destroying a bridge, sent off at a moment's notice forty or fifty miles, to be followed by a muleteer carrying two barrels of powder; without a miner or tools, other than what could be collected in the neighbourhood of the bridge to be destroyed, and with such assistance in manual labour as could be procured on the spot, or by the assistance of some of the dragoons forming his escort." The fate of the campaign may depend on the proper execution of this duty. The following modes are usually adopted: 1. By sinking a shaft in the roadway, generally a few feet to the right or left of the centre of the width of the bridge, down to the haunch of the arch, with a very short gallery ending in a chamber, so as to lodge the powder in the middle of the width of the bridge under the roadway. If the charge is to remain for some time, care must be taken to secure it and the hose or train from damp and injury by traffic over the bridge. 2. When the bridge is very wide, by sinking two shafts and placing two charges of powder—though this method is liable to failure by one charge only exploding, and leaving half the bridge standing. 3. Laying a quantity of powder on the crown of the arch, so as to break it down by the concussion; the French say 100 lbs. are sufficient for this; it is however doubtful. 4. Suspending the charge under the crown of the arch. 5. Driving a gallery into the pier at the springing of the arch, which would be a good plan but for the difficulties attending its execution. "At Duenas in 1812, on the retreat from Burgos, the rear guard of the army was closely pressed by the enemy; the bridge was of solid masonry from the arch to the roadway; the miners had only time to strip off some of the pavement, and lodge two barrels of powder in the hole, covering them as hastily as possible with the small quantity of material at hand: when fired, the effect was to break down the entire breadth of the arch, making a gap of 15 feet." Barriers were formerly destroyed by the petard, this, however, is a clumsy instrument to carry about, and at the present day a bag of powder of about 60 to 100 lbs. is generally all that is found necessary. If suspended or laid against the barrier or gate its explosion is generally found to be effectual, as at the late siege of Delhi, and at Ghuznee in 1839, where, however, 300 lbs. in twelve sand-bags was used.

DEMONSTRATION. The old use of this word is as follows: It meant any manner of *showing* either the connection of a conclusion with its premises, or that of a phenomenon with the asserted cause. Thus we find it asserted by an early writer that the system of Copernicus, *though false*, gave *truer* demonstrations of the celestial motions than any other: meaning that those motions could be more easily shown to be a necessary consequence of the hypothesis cited than of any other. It is very important, in reading the old English writers, to remember this use of the term.

Demonstration now means only that process by which a result is shown to be a necessary consequence of the premises from which it is asserted to follow, on the supposition that those premises are admitted, either as matter of fact, or of intuitive evidence, or of previous demonstration. Thus the 47th proposition of the first book of Euclid demonstrates a certain property of a right-angled triangle, on the supposition 1, that all the preceding propositions are true; 2, that the axioms used in geometry, whether expressed or implied, are true also. It makes the consequence as certain as the premises, by means of the indubitable character of the connecting process. This strict use of the term demonstration belongs to the science of logic, which contains the art of demonstrating from premises, without reference to the truth or falsehood of the premises themselves.

But in common life the word demonstration means any sort of reasoning which the party using the term chooses to call proof. "I consider it as demonstrated," means the same thing as "evidence has been offered which makes it so probable to me that I am willing to act upon that evidence." Most minds have no idea of a middle state; they either absolutely receive or absolutely reject: so that in fact demonstration comes with any degree of balance of evidence on one side or the other. It is easy to admit that in common life high probability is the ground of assent, and that it never can be otherwise: but there is mischief in the use of the same term both for logical inference and for its mixture with matters of guess, or feeling, or unassisted perception. The logician might consent to abandon the word demonstration for popular use, and to adopt another: but it would result that the new word, whatever it might be, would immediately be seized by those who confound what is commonly called argument with what is actually demonstration. Whatever may be the strongest term in use, it will be adopted by strong asserters: nor will he who has shown probable reason, however great, for the adoption of a result of argument, be satisfied unless his conclusion be received as *certain*. What we have here said refers entirely to the use of the word demonstration: the fallacy to be feared is the placing in the result of it, in one sense, the degree of confidence which is only obtained by confounding that sense with another. Two parties, both convinced that a conclusion has a high degree of evidence, dispute whether the evidence *amounts to demonstration*. To settle this point, they sift the evidence most minutely, and perhaps entirely forget to inquire whether they mean the same thing by the word demonstration. Every proposition has its contradiction: and of these one must be true and one false. When the truth of the proposition is proved at once, the demonstration is called *direct*: but when the contradiction is proved to be false, the demonstration is called *indirect*. (ABSURDUM, REDUCTIO AD.)

DEMONSTRATIONS, in military affairs, are operations of any kind which may be performed for the purpose of deceiving the enemy respecting the measures which it is intended to employ against him.

They consist in displaying an apparent activity in forming or repairing a road, or in sending provisions or stores to a particular place, as if preparatory to a march of troops in that direction; in marking out ground as if for an encampment; and in detaching bodies of troops to make false attacks. Such demonstrations are made chiefly with a view of inducing an enemy to divide his forces, and thus weaken his line at points against which the real movement or attack is intended to be directed.

In order to succeed, however, in these demonstrations, they should be made with great precaution, that they may have every appearance of indicating a serious enterprise: even the troops who are to execute them should be unacquainted with the object in view, lest a deficiency of energy should betray the secret to the enemy, who must be supposed to be on his guard against such attempts, and who may consequently take measures to render them useless.

DEMULCENTS are medicinal agents which have the property of protecting sensible surfaces from the action of irritating matter, by hindering it from coming in direct contact with them. They are thus distinguished from diluents, of which water may be taken as an example, which often lessen acrimony by diluting or attenuating the fluid in which it exists. When much water is present in any demulcent liquid, the action is partly that of a diluent, but the chief benefit results from the bland nature of the substance, or from its viscidity. Demulcents are either solutions, such as mucilage of gum arabic, or certain substances mechanically diffused through water or milk, such as wax, spermaceti, or suet. Their beneficial effects are greatest over the mucous surfaces with which they come into immediate contact, such as the throat, stomach, and intestinal canal, but by sympathy their soothing action would appear to be extended to the mucous surfaces of the lungs, and of the urino-genital organs. Mucilaginous substances such as gum, are not easily digested, unless some bitter or astringent principle be taken along with them; so that demulcents pass along the intestinal canal, shielding it from irritating substances throughout its entire length, though less effectually as they proceed, and become mingled with the various secretions in their passage. They thus afford considerable protection to the inner coat of the stomach and intestinal canal against poisonous agents, and for this purpose, milk, gruel, or oil, are frequently employed, though devoid of any power to disarm the substance chemically of its virulence.

DEMURRAGE, the term used in commerce to denote the money payable to the owner of a ship on the part of the shippers or consignees of goods, as compensation for detention beyond the time stipulated for her loading or discharge, as the same is expressed in the charter-party or bills of lading. It is usual to insert in all charter-parties the number of working days allowed for the loading of the ship, and also for her unloading, and likewise the sum *per diem* which may be claimed for delay beyond those periods in either case, in addition to the stipulated freight. Sometimes the number of working days for loading and unloading are stated together, so that any delay in the one case may be compensated by greater speed in the other. When the owners of the ship enter her outwards for any port, to receive such goods as may offer, and consequently where no charter-party exists, there is no stipulation for demurrage in the port of loading; but in this case it is common to insert on the face of the bill of lading a statement of the number of days after her arrival at her destined port in which time the goods must be taken from on board the ship, and also the rate of demurrage chargeable daily for any exceeding that time. No claim for demurrage can be set up where a ship is detained by contrary winds or stress of weather, nor where the government interferes to lay an embargo, nor where the port is blockaded by a hostile force, but the claim on the part of the ship ceases so soon as the goods are shipped and the clearances are passed at the Custom-house.

DEMURRER (*demorari*, to stay) is that pleading by which a question of law is raised between the parties to an action at law or suit in equity. The party demurring refuses to proceed farther with the pleadings, and requires the judgment of the court whether the last statement of his opponent is sufficient. A demurrer, therefore, admits the truth of the opponent's allegations, and only questions its sufficiency in point of law.

DENA'RIUS, a Roman coin of silver, so called from containing ten ases. It answered to the Attic drachma. After the first Punic war (about 269 B.C.), the denarius became the representative of sixteen ases, and though Augustus reduced it to twelve, it continued subsequently at the value of sixteen as low as the time of Gallienus. Pinkerton says it was worth eightpence of our money; Hussey estimates its value under the commonwealth at 8½*d.*, under the empire at 7½*d.*, of our money. It was the chief silver coin in Rome for 600 years, down to the time of Constantine I.

The earliest denarii are those which have the helmeted head of Rome, the dioscuri, or the head of Jupiter, upon their obverse. Many of them had chariots, bigæ, or quadrigæ, represented on their reverses; such coins were called *bigati* and *quadrigati*. The half of the denarius was called *quinarius*, as containing five ases; the quarter, *sestertius* as money *semistertius*, containing two ases and a half.

Many of the family Denarii, as those of the Ælian, Æmilian, Calpurnian, Didian, Fulvian, Papinian, Tullian, and numerous other families, were marked on the obverse with the numeral X; others of the same and other family coins have the X crossed by an upright or horizontal bar, sometimes taken for a star or asterisk, but clearly intended to designate the value. The denarii which went for sixteen ases sometimes continued to be marked with X, and sometimes had the numerals XVI. Akerman, in his 'Descriptive Catalogue of rare and unedited Roman Coins,' 8vo, Lond., 1834, vol. i., p. 15-19, has given the actual weight of the silver denarii in Troy grains, from Pompeius Magnus to Constantinus Magnus.

The *denarii æris* or *ærei*, of copper, began with the Emperor Valerian, and were at first washed with silver. Pinkerton thinks they came in the place of the sestertius, and that six of them went to the silver denarius, as six of the later sestertii did.

Roman Denarii.

British Museum. Actual Size. Silver. Weight $60\frac{6}{10}$ grains.

British Museum. Actual Size. Silver. Weight $58\frac{5}{10}$ grains.

The word denarius was also applied to the ordinary gold coin of Rome, the *aureus*, in the same manner as the English writers speak of the gold penny of Henry III. *Aurei denarii* are mentioned by Petronius. The denarius aureus was equivalent to 30 silver denarii. The half-aureus, in the same manner, was termed quinarius. From the Romans the name was adopted by the Carlovingian kings in France and Germany, and the coin represented the twelfth part of a solidus. The Arabian dinar has also the same origin.

DENEB, an Arabic word, signifying the tail: it generally means the bright star (β) in the tail of the Lion. [LEO.]

DENGUE (*Scarlatina Rheumatica*) is a peculiar febrile disease, conjoined with sudden severe pains in the small joints, which are usually swollen. It is accompanied by heat of skin, intense pain of the head and eyeballs, and the appearance of a cutaneous eruption on the third or fourth day. It is an infectious disease, and has a tendency to develope itself epidemically. The chief peculiarity of this disease is the combination of the symptoms of an exanthematous fever with rheumatic or neuralgic affections of the joints.

This disease has not been observed in Great Britain. "It has been chiefly prevalent in Rangoon, Calcutta, Berhampore, Benares, Chunaighur, in the East Indies; the island of St. Thomas in the West Indies; the Southern States of America; the ports on the Gulf of Mexico; the towns of New Orleans, Savannah, Charlestown, Philadelphia, and New York. It was epidemic in 1824-28, and nothing appears to have been heard of it again till 1849 and 1850, when it again visited the Southern States of America." (Aitken.)

The general course of the disease is, that the patient is attacked with headache, intolerance of light, chilliness, and pains in the back and joints. The small joints swell, the skin becomes hot, the pulse frequent, and the face flushed. The tongue is red. Sometimes an eruption appears at this stage. This state lasts from twelve hours to three or four days, after which it subsides, leaving the patient very feeble. This remission is, however, only temporary. In the course of two or three days there is a return of the fever and pains, with a thickly coated tongue, nausea, and tenderness of the epigastrium. On the sixth or seventh day a scarlet rash appears on the hands, which rapidly spreads over the whole of the body, and gives relief to the febrile irritation. The eruption is very irregular, sometimes being smooth, but at others being papular, vesicular, pustular, or even furunculous. The symptoms gradually subside, leaving the patient with some rheumatic stiffness, and feelings of weakness and mental depression. During the last epidemic at Calcutta the throat was sore, and the articular symptoms were less obvious.

The treatment of this disease consists simply in the palliation of the symptoms. When the nervous irritability and pain are considerable, then opium has been found of essential service. The disease might at first sight be regarded as a mild form of scarlatina. Some of the symptoms, however, are sufficiently characteristic.

DENIER, from the Latin *denarius*, a French coin, originally of silver. It continued in use, through different modifications, as long as the old system of coinage in France lasted; that is, till 1795. Up to that time, accounts were kept in France in livres of 20 sous or 240 deniers: they have been since kept in francs of 10 decimes, or 100 centimes.

Under the kings of the first race the denier weighed twenty-one grains; under the second race, and in the time of Charlemagne, twenty-eight, and sometimes thirty grains; and under Charles the Bald, thirty-two. At the commencement of the third race of French kings the denier weighed twenty-three or twenty-four grains of fine silver. Philip I. began the practice of mixing copper with the silver; and it is in his time that we find the distinction first made between *deniers Tournois* and *deniers Parisis*, the latter being worth a fourth part more than the former. By the time of St. Louis, 1226, the denier had become so debased as to contain not more than six grains and a half of silver; which was probably the occasion of that monarch's issuing a larger class of coins called *gros deniers d'argent*. The term denier was likewise afterwards applied to the gold money of France.

There were formerly current in France several little copper pieces, which having no proper name, were distinguished only by their value in deniers; such were the pieces of 36, 30, 24, 18, 12, 6, 4, and 2 deniers. The pieces of 4 and 2 deniers were coined at Strasburg, for currency in the province of Alsace, pursuant to a declaration of the 6th September, 1695. Those of 6 deniers were coined in the mints of Aix, Montpelier, Rochelle, Bourdeaux, and Nantes, by an edict issued in the month of October, 1709.

The deniers coined toward the end of Louis XIII. were the work of the famous Varin, and are much admired for their execution.

(Le Blanc, *Traité Historique des Monnoyes de France*, 4to, Paris, 1690; Furetière, *Diction. Universel, v. Denier.*)

DENIZEN. Denizen seems originally to have signified a natural-born subject. But now a denizen is an alien-born, who has been constituted an English subject by letters patent of denization, or by the certificate of the secretary of state for the home department (7 & 8 Vict. c. 66). He is in a kind of middle state between an alien and a natural-born subject. He may take lands by purchase, which an alien cannot; but he cannot take by inheritance, for his parent, through whom he must claim being an alien, had no inheritable blood. The issue of a denizen born before denization cannot inherit to him, but the issue born after may. A denizen cannot be a member of the privy council, or sit in either house of parliament, or hold any office of trust, civil or military, or be capable of any grant of lands, &c., from the crown; nor will the British government, it is supposed, consider an alien who has obtained a certificate merely, entitled to British protection, in his own native, or in any foreign country. [ALIEN.]

DENOMINATOR, the number of parts into which a unit is divided in any fraction; thus, in 7-10th's of a unit, 10 is the denominator. [FRACTION.]

DENSITY. This term is absolutely of the same practical meaning as its measure, SPECIFIC GRAVITY, implying that relation of one mass of matter to another, which is suggested by our knowing that a given bulk of the first weighs more than the same of the second. The term has no absolute meaning; gold is more dense than air, but neither is absolutely dense, nor can we assign any meaning to the latter term. It were perhaps to be wished that the shorter term, density, should be employed instead of the longer one, specific gravity; but as custom has referred to the latter term all mathematical considerations connected with the former, we do not here pursue the subject further. [SPECIFIC GRAVITY.]

DENTILS. [COLUMN.]

DENTITION, DISEASES OF. (*Difficult Teething.*) Every infant at the period of birth, is imperfectly organised. There is no structure, and scarcely any tissue of its body, which has attained its due consistence and firmness. Several of the most important organs are entirely rudimentary, and there is not one that is perfect either in structure or function. Development is the great process unceasingly carried on at every point of the system.

Among the organs the first to be developed after birth are the teeth, and the jaws which are to contain the teeth. These organs are agents indispensably necessary to the performance of a primary and essential function—that of nutrition. Before birth there are no teeth, the nutrition of the fœtus being carried on by nutritive matter derived from the mother. For a considerable period after birth there are no teeth, the nutritive matter by which the infant is to be nourished being still formed for it by the mother. But the infant is ultimately to acquire an existence wholly independent of the mother, and from the moment of its birth—nay, long before the period of birth—processes of preparation are going on in its system which have for their object the formation of an apparatus destined to enable it to prepare and digest food independently of its parent. [DENTITION, NAT. HIST. DIV.]

This apparatus, from its most rudimentary state, possesses a highly organised and delicate structure; and it is placed in a position in which its progressive development is attended with peculiar difficulties, which at first view would appear insurmountable. A bony structure has to be formed and to make its way through the dense substance of the gums; at the same time the jaws have to attain a bulk fitted to receive these structures when duly prepared and evolved. The too hasty evolution of the teeth, or the too tardy growth of the jaws, produces evils in the system, by the disturbance of that balance which is indispensable to the orderly and safe progress of all developmental actions.

Supposing the formation of the teeth in the jaws to have proceeded quite naturally up to the time proper for their evolution, at that period they are included in a firm membranous envelope, and are covered by the thick and dense gum. When the process of dentition proceeds in a natural manner, the membrane and the gum are absorbed in order to make way for the passage of the teeth.

This process, even when accomplished in a perfectly natural manner, is almost always attended with some degree of local inflammation. The gum itself is manifestly red and swollen, and is apparently painful and itching, indicated as well by the obvious occasional uneasiness of the infant, as by the constant desire it evinces to press against the gum everything it can lay hold of. The irritation of the gum extends to the salivary apparatus placed in the mouth and its neighbourhood, as is proved by the increased flow of saliva, which is commonly more or less altered in quality, as well as increased in quantity, being thicker and more tenacious than the natural secretion. These symptoms of local irritation are usually accompanied by a slight degree of constitutional disturbance, the skin being commonly hotter and dryer, the face occasionally flushed, the bowels more relaxed, and the infant itself more restless and fretful than natural. The irritation of the gum when restricted within a moderate limit seems to be the necessary consequence of the developmental process that is going on. The effect of the local irritation, namely, a determination of blood to the salivary apparatus, occasioning an increased flow of saliva, and that of the constitutional disturbance, namely, a determination of blood to the mucous membrane of the intestines, occasioning diarrhœa,—appear to be remedial rather than morbid, to be evacuations established by nature for the purpose of relieving over-distended vessels and over-excited nerves.

When the infant is in a state of sound health, and when the process of dentition proceeds in a natural manner, the local and constitutional evils attending the evolution of teeth amount to no more than have now been described; but when the infant is in a state of either congenital or acquired disease, or when the natural course of the process of dentition is disturbed, evils result always serious and often fatal.

Suppose that the formative proceeds faster than the absorbing process; that the teeth grow with a rapidity with which the action of the absorbents is not commensurate, the necessary consequences are, that the tooth is forced against the gum, that the investing membrane is compressed between them, and that this pressure is communicated to the delicate and soft pulp on which the organisation of the tooth is still proceeding. The effects of the irritation thence induced will vary according to the degree of pressure, the sensibility, and irritability of the individual, and the pre-disposition of its natural or acquired constitution to disease. In some it may produce only a slight aggravation of the local and constitutional ailments already described; in others it may produce every form of disease to which infancy is subject, attended with every symptom appertaining to such diseases.

In the infant, the mucous membrane which lines the alimentary canal, from its commencement in the mouth to its very termination, is highly sensitive and irritable; the membrane which covers the external surface of the body, the skin, which possesses essentially the same structure as the internal lining membrane, and between which there is the most intimate sympathy, is alike sensitive and irritable; the mucous membrane which lines the air-passages, and which forms the air-vesicles of the lungs, is scarcely less sensitive and irritable. Morbid irritation excited in any of these extended and most important surfaces is readily propagated to the great nervous centres, the spinal cord and brain, in which are induced, often with extreme rapidity, some of the most formidable diseases to which the human body is subject; and from diseases established in the spinal cord and brain disease is reflected back upon the muscles. Thus the most prominent diseases produced by abnormal (irregular) dentition have their seat in the stomach, the intestines, and all the organs which form a part of the digestive apparatus; in the external skin, in the air-passages and lungs, in the spinal cord and brain, and in the muscles of voluntary motion.

The irritation attendant on abnormal dentition commences in a portion of the mucous surface of the digestive apparatus, and from its source in the mouth it is readily propagated to the stomach, intestines, and liver, producing in the stomach pain, nausea, vomiting, flatulence, acid eructations, &c.; in the intestines, griping pain, flatulence, diarrhœa; in the liver, disordered secretion of bile, in consequence of which the fæcal evacuations are greatly altered in quantity and quality, being at one time too scanty, and at another time too copious, sometimes light or clay-coloured, and at other times dark-green, spinach-like, and preternaturally fœtid, mixed with large quantities of unhealthy viscid mucus.

The external skin sympathising with the irritation set up in the internal mucous surface, is constantly affected with eruptions of various names and natures, sometimes attacking the scalp, sometimes surrounding the lips and extending over the face, and at other times covering the whole body.

The irritation is propagated from the mucous membrane of the mouth and fauces to that of the air-passages and air-vesicles, inducing hurried, difficult, and painful respiration, frequent cough, and all the symptoms of inflammation of the lungs.

There is the closest possible connection between the skin, the digestive surface, the respiratory surface, and the great nervous centres, the spinal cord and brain. Any irritation excited in the former is readily propagated to the latter. There is a direct route by which the intercourse is established. The nerves proceeding from all these surfaces take a direct course to the spinal cord and brain, where they communicate the irritation which they receive, and excite, among other diseases, more especially that which constitutes hydrocephalus acutus, or water in the head. This disease, among the most formidable to which infancy is subject, and the most common cause of which is abnormal dentition, is preceded by the start in sleep, the slight chill, hardly amounting to rigor; the flushed face; the sudden, darting, transient pain in the head; the unusual drowsiness; and then come the sudden start from that deep sleep, with a loud scream; the injected eye, the dilated pupil, followed by the constant rolling of the head upon the pillow, the loss of sight, and the progressively increasing insensibility and coma. The irritation thus produced in the spinal cord and brain is quickly reflected back upon those muscles the action of which depends upon an influence derived from these great nervous centres—the muscles of volition, which are affected with twitchings, spasms, convulsions, sometimes passing into chorea, epilepsy, catalepsy, and tetanus.

When the acute symptoms induced by inflammation of the brain, followed by effusion, pass away without immediately destroying life, it is often only to leave a state of permanent idiotcy far worse than death.

Besides all these evils produced by abnormal dentition, there is one specific disease that results from it of a most formidable nature, and often fatal. This affection may be termed the disease of development; it is commonly called infantile remittent fever. The accession of this disease is denoted by languor, lassitude, chilliness, shivering, succeeded by heat of skin, perspiration, and accelerated pulse. The little patient is spiritless, discontented, and fretful. Yawning, sighing, marked increase of irritability, unusual mutability of temper, loss of appetite, perhaps alternating with importunate desire for food, which when given often cannot be eaten, some peculiarity of respiration, and at last impatience of light and sound, accompany or quickly follow a distinct febrile attack. The feverish symptoms disappear or remit soon to recur or exacerbate; and these remissions and exacerbations are characteristic marks of the disease. The colour of health is gone, and the colour often changes. A flush of the countenance, preceding slight rigor and paleness of face, is succeeded by slight headache. There is a remarkable desire to pick, principally the nose, sometimes the lips and fingers, often other objects; frequently the breath is offensive, and cough, headache, and griping pains in the bowels are present, with more or less of sickness, faintness, sighing, starting, more particularly in sleep, moaning in sleep, grating the teeth, sleeping with the eyes half open, and a relaxed or on the contrary an exceedingly constipated state of the bowels. Occasionally the pupils suddenly dilate, perhaps only one pupil, and then as suddenly contract. "Perspiration is part of fever, and this is sometimes observed night after night succeeding to no very remarkable heat of skin, but to a great drowsiness, which in itself is a proof of exacerbation, though the accelerated pulse of fever may be wanting. The moaning, picking, or starting, with any of these conditions, constitutes part and parcel of this disorder. Sometimes the ailment is slight in degree, or it may assume an acute form with all the fire and anger of a hot fever. Sometimes it is typhoid in its type. Whatever character may be assumed by this disorder, it is coincident with an irregular course of the development of some organ of the body; and commonly the irregular development is in the nutrient organs, and of these most commonly the teeth and jaws."

Fatal disease may arise from abnormal dentition long before the usual period of cutting the teeth. A turgid condition of the vessels about the soft and delicate pulp, and in the membrane that envelopes the whole rudimentary tooth, may compress the dental and even the maxillary nerves; and pressure on these nervous tendrils may, under certain conditions, be tantamount to pressure applied directly to certain parts of the brain; hence irregularity in the course of growth, at the earlier period of teething, may produce a sufficient degree of pressure to excite a high degree of irritation in the brain, producing even fatal convulsions. Many striking cases of this kind are on record, of which the following brief history may serve as an example: A fine healthy-looking child, of a strong healthy mother, died, at thirteen weeks of age, of a convulsive fit. The cause of death was ascertained, at the earnest wish of the mother, by a careful examination of the body after death. The internal organs, for the most part, were healthy; the stomach contained only a little milk; the mucous surfaces of the intestines were free from disease; the contents of the thorax were healthy. In the head, the membranes that envelope the brain, and more especially the pia mater, were more tinged with blood than natural, but the brain itself was healthy. The jaws were carefully examined. "The capsules of the incisor teeth were large and very vascular, much more advanced than usual. With a lancet, the cartilaginous rim of the lower jaw was attempted to be removed, with a view of exposing the capsules of the molar teeth; but these were so unusually distended with fluid, that the instrument cut into them and let it out. This was an example of development proceeding too hastily."

It is common for the symptoms of irritation which attend on the evolution of the teeth to appear about the third or fourth month; they usually precede the appearance of the teeth by several weeks, and they occasionally subside and then re-appear a short time before the tooth makes its way through the gum.

Disease arising from abnormal dentition is not confined to the period of infancy. In children of irritable constitutions in whom the maxillæ are imperfectly developed, the irruption of the second or permanent teeth is sometimes attended with serious and even fatal disorders. Nay, even the period of adolescence is by no means free from severe diseases produced by this same cause; for in consequence of the development of some of the teeth having been preternaturally delayed, or in consequence of an imperfect development of the jaws, at the period when the dentes sapientiæ are about to appear, delicate, nervous, and irritable subjects are not unfrequently affected with swelling of the parotid and submaxillary glands, painful and sometimes periodical affections of the ear and face, slight or recurring ophthalmia, irregular convulsions, epilepsy, and chorea; which affections have disappeared at once upon the irruption of the teeth or the removal of the local irritation.

Animals are not afflicted with these or any analogous evils from the evolution of their teeth, and they are produced in the human species altogether by the unnatural circumstances in which the infant is placed in the present artificial state of society. The chief causes of these grievous evils are: 1. Food, unnatural in quality and too great in quantity. It is seldom that an infant lives solely upon its natural food (human milk) during the early months of its existence. If it take other food, that food is either digested or it is not. If it be not digested, numerous ailments are produced; if it be digested, the system is too highly nourished, and becomes too full of blood, from which it is easy to see that any one or any number of the diseases which have been described may result. 2. The practice, too common in this country, of keeping the heads of infants and young children very warm by clothing, by their wearing flannel caps, and by having their heads almost constantly wrapped in a warm woollen shawl, from the dread of their catching cold. The naturally great determination of blood to the head is too much favoured by this practice, which co-operates more powerfully than may at first view be apparent with the other circumstances that conspire to produce disordered dentition. 3. The confinement of infants in close and heated apartments, in the impure air of large towns and cities without exercise. Such children in whom all the evils of dentition are most frequently produced in the severest forms, are deprived of the natural stimulus afforded to the varied processes of growth by pure air and active exercise.

The treatment of the various and formidable diseases produced by abnormal dentition can never be judiciously conducted without a constant reference to the causes on which they depend. Without a proper regulation of the diet, clothing, air, exercise, and a state of the bowels, nothing can be effectually done to prevent the occurrence of the most formidable of these evils. When they are actually present no remedy can be other than palliative which does not aim at two things: first, the entire correction of everything ascertained to be faulty in the diet, clothing, &c. &c.; secondly, the removal of pressure upon the nerves, produced by the advancing and unliberated tooth, which occasions all the mischief. "As soon therefore as any of the affections now described, or any others which can possibly be supposed to arise from this cause, make their appearance, the gums should be carefully examined, and wherever there is any unusual redness or turgescence, and especially if it occur over the part where the next tooth is expected to appear, the including parts should be freely and effectually divided. It is not sufficient that the incision should merely pass through the gum, the lancet must be carried down to the rising tooth itself, and only stopped when the resistance of its point is felt against the edge of the instrument. The form of the gum-lancet should be broad and somewhat rounded, and its edge extremely sharp. The only precaution necessary in its use is so to direct it in making the incision that the cord of connection between the temporary and permanent tooth shall be carefully avoided, which is readily insured by directing the edge rather towards the outer part of the gum.

"The prejudices of former times against this simple and most efficacious operation are fast yielding to the frequent evidence of its harmlessness and utility. It is impossible for the most prejudiced to witness the effects which continually result from it without becoming a convert to its use. In the midst of the most imminent danger, when death has almost been anticipated as the only relief from severe and hopeless suffering, this simple and trifling operation has, in innumerable instances, restored the little sufferers to their parents in a state of ease and safety, and in so short a space of time as would scarcely have appeared credible."

There are few cases in the management of disease which require more prompt decision in the application of remedies or more judicious selection of remedial agents than some of the sympathetic affections which have been now adverted to. Life will often depend on the choice of the remedy which is made, and the cautious boldness with which it is administered. It is not possible here to pursue the discussion of this subject further than merely to add that the bowels should be constantly kept in a somewhat loose state; that if a slight degree of diarrhœa be naturally established, nothing whatever should be done to check it; that even when the purging becomes considerable, it should be only moderated, not stopped; and that the most extreme caution should be exercised in meddling with any eruptions upon the skin.

(Bell *on the Teeth*; Dr. Ashburner *on Dentition*; Dr. John Clarke's *Commentaries on the Diseases of Children*; and Copland's *Dictionary of Practical Medicine in Loc.*)

DENUNCIATION. [DILIGENCE.]

DEODAND (*Deo dandum*, given to God). This name was given to whatever personal chattel occasioned the death of a man without the default of another, and also to the instrument with which murder was committed; because by our ancient law these chattels were forfeited to the crown, to be applied to pious uses and distributed in alms by the high almoner.

Blackstone supposes "that the custom was originally designed in the blind days of popery as an expiation for the souls of such as were snatched away by sudden death, and for that purpose ought properly to have been given to holy church, in the same manner as the apparel of a stranger who was found dead was applied to purchase masses for his soul." But it is perhaps more reasonable to imagine that it was a civil institution intended to produce care and caution on the part of the owners of cattle and goods, and that the subsequent application of the things forfeited has been mistaken for the origin of the law itself. The custom was also a part of the Mosaic Law. (Exod. xxi. 28.) In England it prevailed from the earliest period, the custom being mentioned by Bracton, one of the earliest writers on English law, who lived in the reign of Henry III. "Omnia quæ movent ad mortem sunt deodanda," which is Englished in the 'Termes de la Ley:'—

What moves to death, or kill'd the dead,
Is deodand, and forfeited.

Deodands were abolished by stat. 9 & 10 Vict., c. 62. (Blackst. 'Comm.,' Mr. Kerr's ed., vol. i. p. 297.)

DEPARTMENT (or in French DEPARTEMENT), a territorial division of France, introduced by the States General in the latter part of the reign of Louis XVI. The departments are divided into arrondissements, cantons, and communes. They will be found described under France, and each department by name, in the Geog. Div.

DEPARTURE, a nautical term used to indicate the number of miles which a ship has sailed eastward or westward; and it always has reference to a certain meridian which the ship was upon, when her previous position had been calculated.

When a ship sails on any course but true north or south, she leaves or "departs" from her meridian: hence the word.

From the obliquity of the course in such cases, when not sailing due east or west, a triangle is formed, of which in "dead reckoning" the base is assumed to be the "departure," the perpendicular being the difference of latitude, and the hypothenuse the distance. In its most simple form, that of plane sailing, the earth's surface is for convenience supposed to be flat; hence the term departure can only be applicable to short distances, such as a day's run.

The difference between departure and longitude may be thus illustrated: If we construct a right-angled triangle, of which the base contains the number of given miles of declination, and make the acute angle at the base equal to the given latitude, the hypothenuse will measure the corresponding geographical miles of longitude,—or, by logarithms, Cos. Lat. : Dep. : : Rad. : Diff. Long.

$$\therefore \text{ Diff. Long} = \frac{\text{Dep.} \times \text{Rad.}}{\text{Cos. Lat.}} \text{ and}$$

$$\therefore \text{ Dep.} = \frac{\text{Cos. Lat.} \times \text{Diff. Long.}}{\text{Radius.}}$$

Taking a departure is the ascertaining of the ship's position with rogard to some prominent headland which is in sight at the time of commencing what is called a sea log, and it fixes the starting-point for the voyage. This is generally done by one of three methods, namely:—

1. Either a single bearing [Bearing] is taken of some known object on shore, and its distance *estimated*; or,

2. A bearing is first taken of one object, and after sailing a measured distance on a known compass course, a second bearing is taken of the same object, and the required side of a triangle thus found is measured or computed; or,

3. Two land objects being in sight, the bearing of each is taken at the same moment in the ship, and from these bearings laid off as reversed upon the chart the exact distance is at once measured: that between the two objects on the chart forming the base line of the triangle.

In estimating at sea distances from high land in sight, so much depends on the state of the atmosphere [Refraction] that even a practised eye is liable to considerable error; so that a second or cross bearing, if obtainable, is always to be preferred.

The position of a ship from the land on taking a departure, is usually considered as if the first course in the traverse. [Sailings; Navigation; Longitude.]

DEPARTURE. [Pleading.]

DEPHLOGISTICATED. A term used by the chemists of the last century to denote bodies which had been burnt; or, according to the then prevailing theory, deprived of their phlogiston. [Chemistry, *George Earnest Stahl.*]

DEPHLOGISTICATED MARINE ACID. [Chlorine.]

DEPLOY, to extend in a line of small depth, an army, a division, or a battalion, which has been previously formed in one or more columns.

DEPORTATION. [Banishment.]

DEPOSIT. This term is applied to the sum of money which, under 43 Geo. III. c. 46, a man may deposit with the sheriff after he is arrested, instead of putting in special bail. [Arrest.]

Deposit is also used for any sum of money which a man puts in the hands of another as a kind of security for the fulfilment of some agreement, or as a part payment in advance.

The Roman word *depositum* signified anything which a man put in the hands of another to keep till it was asked back, without anything being given to the depositarius for his trouble. The depositor was called deponens or depositor. The depositary was bound to take care of the thing, and to make good any damage that happened to it through fraudulent design (*dolus*) or gross neglect (*lata culpa*). The depositor could recover the thing by action; but the depositary was entitled to satisfaction for any loss that he sustained in the matter of the deposit by any default (*culpa*) on the part of the depositor. The depositary could make no use of the deposit, except with the permission of the depositor, either given in express words or arising from implication. If a man refused to return a deposit, and was condemned in an action of deposit (*actio depositi*), infamy (*infamia*) was a consequence of the condemnation.

('Dig.' 16, tit. 3; Juvenal, 'Sat.' xiii. 60.)

DEPOSITION in its extended sense means the act of giving public testimony, but as applicable to English law the word is used to signify the testimony of a witness in a judicial proceeding reduced to writing. Informations upon oath and the evidence of witnesses before magistrates and coroners are reduced into writing in the very words used by the witnesses, or as near as possible thereto. Evidence in the Court of Chancery is now, under 15 & 16 Vict., c. 86, taken orally by examiners who write down the evidence given in the form of a narrative, which is read over to and signed by the witness. According to the ancient practice, which may in some cases be still resorted to, evidence was taken in written answers to interrogatories, which were in writing, either by commissioners appointed by the court for that purpose in the particular cause, if the witness resided at a greater distance from London than 20 miles, or before the examiners of the Court of Chancery. The Court of Chancery has power to grant a commission for the examination of witnesses residing abroad; and by the 1 Will. IV., c. 22, extending the provisions of the 13 Geo. III., c. 63, the courts of law at Westminster, in actions pending before them, have power to order the examination of witnesses residing in any of her Majesty's foreign dominions. When a witness is above the age of seventy, or very infirm, or about to go abroad, so that his testimony may be lost before the regular period for his examination arrives, the Court of Chancery will order him to be examined *de bene esse*, as it is termed; that is, his examination is received for the present, and will be accepted as evidence when the proper time for taking the other evidence in the cause arrives, if the witness cannot be then produced. Courts of law do not possess similar power without the consent of both parties, but in order to enforce consent they will put off the trial at the instance of a defendant, if the plaintiff will not consent: and if the defendant refuse, will not give him judgment in case of nonsuit.

The Court of Chancery will also, upon bill filed by a person in the actual and undisturbed possession of property, and who has therefore no means of making his title the subject of judicial investigation, but which nevertheless may be materially affected by the evidence of living witnesses, allow the witnesses to be examined in *perpetuam rei memoriam*, that is, to perpetuate testimony. This is done in order that if any of the witnesses should die before the title to the property is disputed, their evidence may be preserved, otherwise a claimant might lie by until all the evidence against him was lost.

Depositions are not admitted as evidence in courts of law, unless the witness is either dead, or, from some cause, beyond the control of the party seeking to read the deposition, cannot be produced, or against any other persons than the parties to the proceeding in which they were taken, or claimants under them, and who had the opportunity of cross-examining the witness. In cases, however, relating to a custom, prescription, or pedigree, where mere reputation would be good evidence, a deposition may be received as against a stranger.

Depositions taken in Chancery *de bene esse* before answer put in, unless the defendant is in contempt for refusing to answer, are not admissible as evidence in a court of law, because until the defendant has answered he could not have an opportunity of cross-examining the witness; but the Court of Chancery will sometimes direct such depositions to be read. Such order, however, while it concludes the parties, is not binding upon the court of law: of course, however, if the depositions be not read and the decision should be contrary to justice, the Court of Chancery would interfere as between the parties. [Equity; Evidence.]

DEPRESSION (Algebra), the reduction of an equation to a lower degree, by dividing both sides of it by a common factor. Thus $x^3-x-6=0$ having been found to have 2 as one of its roots is *depressed* to an equation of the second degree by dividing by $x-2$, which gives $x^2+2x+3=0$: that is, the two roots of the latter equation are the two remaining roots of the former.

DEPRESSION, ANGLE OF, is the angle by which a line drawn from the eye to any object dips below the horizon. [Elevation, Angle of.]

DEPRESSION OF MERCURY. [Barometer.]

DERIVATION. The term *law of derivation* almost explains itself. Thus in finding the successive differential co-efficients of a power of x, the law is,—to get the next differential co-efficient, multiply the last by its exponent, and reduce the exponent by a unit. To treat of derivation in the most general sense would be to write a work on mathematical analysis, of which it may be said that most of its difficulties arise from want of sufficient knowledge of methods of derivation. But there is a more restricted use of the term, derived from the work of Arbogast, in which it applies to those laws of derivation which spring out of Taylor's Theorem. Hence the differential calculus, considered either in the manner of Lagrange, or in that of Arbogast, is sometimes called the calculus of derivations. Lagrange himself calls the differential coefficient a derived function, the objection to which is the application of a generic term to one of its particular cases. For the successive logarithms, sines, &c., differences, integrals, &c., of a given function, are also functions derived from the original in different ways. Nevertheless, the fundamental processes of the differential calculus have appropriated the word *derivation*; but in this way: the *derived function* nearly always means the differential coefficient, while the substantive *derivation* is nearly always used in reference to the method of Arbogast.

DERVISH is a Persian word, properly an adjective, which signifies poor, indigent; as a substantive it is used to denote a religious mendicant, hermit, or any one who retires from social life in order to devote himself entirely to religious contemplation. It is synonymous with the Arabic *Fakîr*, and both expressions are chiefly employed to designate a class of persons in Mohammedan countries nearly corresponding to the different orders of monks among the Christians. It would be difficult to determine the age to which the origin of the dervishes is to be referred. From time almost immemorial, pious men in the East, as elsewhere, seem to have thought it meritorious to renounce the enjoyment of temporal things and the ties of domestic and social relations, and to live in poverty and solitude for the purpose of turning their thoughts altogether towards spiritual matters. Oriental tradition makes the order of hermits as ancient not only as St. John the Baptist or Elias, but even as the time of Seth. In the *Koran* poverty is recommended as meritorious; and Mohammed is reported to have said, "See that ye come poor before God, for the poor shall have the first place in his mansion." Jâmi, the well-known Persian poet, is the author of an esteemed work on the lives of the *Sûfîs*, or Mohammedan mystics. Among the Turks several orders of fakîrs or dervishes exist. The principal one is that of the *Maulavîs*, founded by the celebrated Persian poet Jelâleddîn Rûmî, who died in 1262. The dervishes of this order have a great monastery at Galata, and another at Iconium. Their demeanour is very humble, and their robes are extremely coarse; besides the fast during the month of Ramazan, they keep a weekly fast on every Thursday. It is part of their religious practices to turn round with great velocity to the sound of a pipe, repeating loudly and slowly the words "La illah illahlah," dwelling on each syllable; and, when the music ceases, to stop at once, without showing symptoms of giddiness. They may leave their order, and are then released from their vow of chastity, and permitted to marry. Some amuse the common people by tricks of legerdemain, or apply themselves to the practice of sorcery and conjurations. They are notorious for their fondness for intoxicating liquors and for opium. They have convents in nearly all Mohammedan countries, which serve the travelling pilgrims of this order as inns. The order of the Rufâïs, or howling dervishes, founded 1182, by Sheikh Ahmed Rufâi, is distinguished by the strange excesses of self-mortification to which its members are carried by their fanaticism. In their weekly assemblies in the hall of their convents, some are always selected to hold a red-hot piece of iron between their teeth till it becomes cool, while the others make deep incisions in their bodies with sharp-edged instruments. Another class of dervishes is that of the *Calenders*. They are distinguished by the singularity of their dress, which is sometimes made of party-coloured cloth, and sometimes consists of a tiger's or sheep's hide, or is made of iron. Frequently the Calenders go about half-naked, with their skin painted red or black. They wear feathers in their ears, and have their heads covered with hats or turbans of a fanciful shape. In their girdles they carry a plate or bowl, which they hold out to receive charities. They often visit coffee-houses and other places of public resort to preach, and act as if they were inspired. In their religious opinions, the greatest variety prevails. There are other orders, distinguished by certain peculiarities, some of which are of older origin than the above, but none are of equal importance. The dervishes do not seem to be much respected by the public; they are considered as hypocrites, who have assumed a sanctimonious appearance in order to have a pretext for idleness, and who clandestinely indulge in the grossest licentiousness. All dervishes, with the exception of the Maulavî, are allowed to marry; but they are obliged to sleep one or two nights in the convent of their order.

(Paul Rycaut, *The Present State of the Ottoman Empire*, 1668; Von Hammer, *Geschichte der Osmanischen Reichs*.)

DESCANT, in Music (the etymology is doubtful) signifies, in strict language, a melody or air, extemporised on a *canto-fermo* [Plain Chant], or, in other words, an enlarging *all'improvviso*, that is, unpremeditatedly, on a given subject, which subject, sung by another voice, or other voices, forms the accompaniment of the descant. Thus the term was understood in the 11th and 12th centuries, both by Franchinus and John de Muris; but afterwards it became synonymous with counterpoint. [Counterpoint.] It has now, however, fallen into disuse, and is seldom met with, except in dictionaries.

DESCENT, in English law (from *discent*, Norman French and so written in our older law books), may be defined the act of law by which on the death of the owner of an inheritance, without making any disposition thereof, it is cast upon another as an heir. Inheritance is sometimes used in the same sense, though it rather signifies that which is, or may be, inherited, or taken by descent. (Littleton, sect. 9.)

1. The law of inheritance with respect to descents which have taken place since, or shall take place after the 1st of January, 1834, is now regulated by the Act 3 & 4 Wm. IV. c. 106, but some notice of what the law was before that time is necessary; since it is the constant practice, in the investigation of titles to property, to inquire what happened fifty or sixty years ago.

2. The death of the owner of the inheritance is the occasion of the descent of it. In his lifetime, there can be no descent, and therefore no heir, though there may be an "heir apparent," or "heir presumptive;" an heir apparent being he who must be the heir, if he lives till the inheritance descends; an heir presumptive, he who may be forestalled by the birth of a nearer heir.

3. The person who dies must be at his death owner of the inheritance, or no descent of it will then take place.

4. Inheritances, *hereditaments*, things which may be *inherited* or *taken by descent*, are various. The principal of these is the crown, the descent of which differs in one material respect from that of a private inheritance, inasmuch as where there are no sons of the king, an elder daughter takes the whole of the inheritance, in exclusion of the younger sisters. Again, dignities and honours, as baronies and other peerages, are descendible, according to the limitations contained in the patents by which they were created. If created by summons in the first instance, they are called dignities in fee, and are descendible to females. [Barony.] Finally, all the subjects of real property and all annuities, offices, and whatever other things may be "held in fee," are "descendible," and this whether they are in possession, reversion, remainder, or expectancy. So are all rights and titles to things that may be held in fee, and the expectancy of an heir apparent or presumptive. There are also "descendible freeholds," that is, estates created by leases for lives, which, though not estates in fee, may during their continuance be inherited as if they were. It has been already noticed [Chattel] that the large class of things called chattels are not generally the subject of descent, but that some of them are.

5. Upon the death of the owner, the law casts the inheritance upon the heir, without any act done by him, or price paid for his acquisition: in both these respects, the present law of descent differs from the old feudal customs from which it is derived. According to the old feudal customs, upon the death of the tenant of a fee, the lord of whom it was held was entitled to take and retain it till the heir, for whom proclamation was made, appeared, and paid a sum of money called a relief [Relief] as the consideration for his admission into the tenancy; whereupon "seisin" or possession was given him, and he took the "oath of fealty" [Fealty], and if the tenancy was by "knight's service," "did homage" [Homage] also to the lord. All this was more like a new donation, than the present quiet succession of an heir. The descent of copyholds, however, is still regulated much in the manner described. The heir was not however formerly, to the same extent as now, subject to the charges and debts of the deceased tenant, in respect of the property descended [Assets]; and he had also an advantage, which is much insisted and commented upon by the old law writers, though its value is not so apparent to us. The descent of an inheritance of which the rightful owner had been *disseised* or unlawfully dispossessed, prevented him from making an *entry* upon the heir of the disseisor, or bringing an action of ejectment, the right to maintain which is founded upon the right to make an actual entry, and left him only "a writ of right," or other real action, for the recovery of his property. One whole chapter of Littleton's 'Tenures' is taken up with treating of descents which "toll" (take away) entries, but a late Act (3 & 4 Wm. IV. c. 27) prevents descents from having any longer this effect. The present law of descents qualifies materially in one respect the title of the heir to the inheritance descended. Though it makes him as completely the owner of it as if he had purchased it, as to right of enjoyment and power of alienation, it does not allow it at his death to descend as if he had purchased it; but, on the contrary, declares that it shall descend as if he had never had it. Such at least is the new law (s. 1, 2 of the Act). The heir of an inheritance must be always the heir of the last "purchaser" of it, that is, of the last person who acquired the property "otherwise than by descent, or than by an escheat partition or inclosure, by the effect of which the land shall have become part of, or descendible, in the same manner as other land acquired by descent." The practical importance of this rule cannot be understood without knowing who the person is who in any case is designated by the law as the "heir" to another.

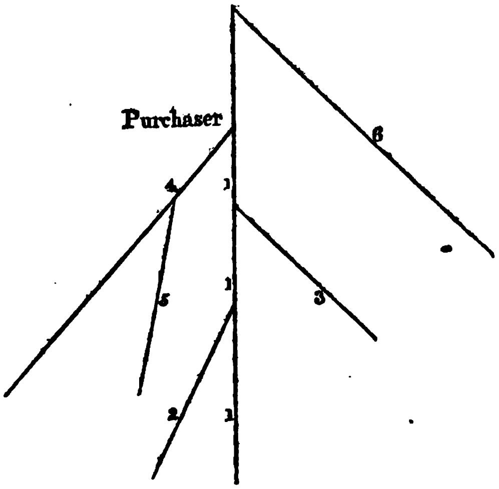
As to descents in fee simple, the fundamental rule is, that any person *of kin* to another, that is, descended from the same ancestor, however distant, may be his heir, but that no person connected with him by marriage or affinity only [Affinity], can inherit to him. If the son inherits to the father, his mother cannot succeed to him, for though she may be heir to the son, she cannot be heir to the father, from whom, and not from the son, "the descent is to be traced." On the other hand, if the father inherits to the son, the mother may succeed to him, for though she cannot be the heir of the father, she may be the heir of the son. The fee, fief, or feud, which may thus now descend to the kindred of the purchaser *in infinitum*, was once nothing more than a life interest given to the tenant or holder of it in consideration of the military services to be rendered by the latter to the donor. [Allodium.] The fee was afterwards permitted to descend to the issue of the original grantee, and in process of time to his *collateral* heirs. This was only effected by means of a fiction; for so firmly settled was the notion that "the blood" (descending) alone of the purchaser or original grantee could be allowed to inherit, that the feudal law was never brought to allow collateral heirs, as such, to be heirs. But when a feud was granted *ut antiquum*, that is, to be held by the donee as if it had descended to him from some remote unknown ancestor, then the law permitted collateral relations however distant, that is, relations descended from any common ancestor, however remote, to inherit. For it was not known how far distant the ancestor was who was supposed to have been the purchaser, nor who he was, and it was sufficient that the heir *might* be a descendant of his. (See for the early history of inheritable fiefs, Robertson's 'Charles V.' Sullivan's 'Lectures;' Wright's 'Tenures;' Gilbert 'on Tenures,' by Watkins; Butler's 'Coke upon Littleton,' 191, a, n. where there is an excellent comparison of the Roman and feudal laws of inheritance.)

While the law however went thus far, it did not, for reasons which some writers have attempted to explain, allow the *lineal ancestors* of the purchaser of the *quasi* ancient feud to inherit it, nor his relations by the half-blood, that is, persons descended not from the same father *and* mother as the purchaser, or any lineal ancestor of his, but from one of them only. Still further exclusions followed from the rule which was afterwards established, that the heir of the fee must be the heir of the person last *seised* or possessed of it, as well as a kinsman of the whole blood to the actual purchaser. Among the practical consequences of this rule were the following: That if the child of the actual purchaser inherited to him, and became seised, the purchaser's child by another wife could not succeed, because only half brother to the person last seised; and that if the father's brother inherited to the son and became seised, the mother's brother could not succeed, because only related by marriage to the person last seised. All these exclusions and the fictions of the ancient feuds are done away with by the new Act, the effect of which is, as before said, to admit among the heirs of the purchaser all his kindred, both of the whole and the half blood, and notwithstanding any previous descent to any heir of his. This it does by enacting that every lineal ancestor shall be capable of being heir to any of his issue (s. 6); that any person related to the purchaser by the half blood shall be capable of being his heir (s. 9), and that in every case descent shall be traced from the purchaser (s. 2). Still, however, the wife or her relations cannot inherit to the husband, nor the husband or his relations to the wife. But the hardship of these exclusions is at least mitigated by the law of dower and curtesy, which must be read together with the law of descent as one law. It remains to show in what order the kindred of the purchaser inherit. The old law on this subject is reduced by Blackstone to seven rules, which have been generally copied by later writers; but the new Act so interferes with them, and they seem, besides, to be so capable of being simplified, that we shall propose instead of them the following rules, which, it is believed, embody the present law on this subject. We shall follow Blackstone's plan of stating the rules in the order in which they may have to be applied in searching for an heir.

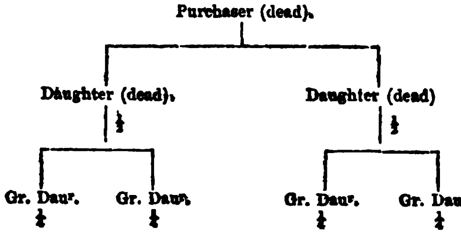
1. The child (if any) of the last owner deceased is the heir of the purchaser. Thus not only is the child of the purchaser his heir upon his death, but if any other heir of the purchaser dies after having inherited, *his* child is the heir of the purchaser.

2. The person through whom another must trace his descent from the purchaser is (if living) the heir before that other person. Now, bearing in mind that descent is always to be traced lineally, that is, either from parent to child, grandchild, &c., or *vice versâ*, it follows that the purchaser's child must, if living, inherit before *his* child, the brother before the nephew, the father before the brother or the grandfather, &c. If the purchaser had a child who died in his lifetime, leaving a child, that child is the purchaser's heir, according to rule 1; for the expectancy of the child of being next heir to the purchaser descended upon his death to his child, as being his next heir, who consequently becomes, upon the purchaser's death, *his* heir. It is surprising that this plain and certainly true explanation of the effect in question has been overlooked by all the writers on the law of descents, who lay down a separate rule (the 4th of Blackstone's) to account for it.

According to these rules 1 and 2, the effect of which is very much to simplify the course of descents, when an inheritance has once got into a *line*, it will keep continually descending in that line, till the line ends; and then it will only go back as far as the head of the next line, which springs from the line in which it has been descending, and will descend in that line, and so on; thus:—



3. Of persons related to each other, as brothers and sisters, the males inherit before the females: the former successively in order of birth; the latter altogether in equal shares, being therefore called *coparceners*. (This rule is qualified by rule 5.) Hence the sons of the purchaser inherit before the daughters, and first his eldest son, then his second, &c.; then all his daughters together. It makes no difference whether the coparceners are related to each other by the whole or the half blood. This division among females often causes the minute splitting of inheritances, as thus:—



According to the custom of *gavelkind*, all the sons, and in default of sons, all the daughters inherit together as coparceners. As to the custom of Borough English, see that title.

4. Every male ancestor inherits before any female one. This is qualified by rule 2. (See s. 7 of the new Act.) Hence the father takes before the mother, &c., but not the mother's father before her, for he claims through her.

5. Those who are relations by the half blood to the purchaser inherit next after their brothers and sisters, who are relations by the whole blood to the purchaser. (Qualified by rule 4 and 2: see s. 9 of the new Act.) What the half blood is has been already explained. Thus (by an exception to rule 3) the half brother takes after the whole sister, and the half sister does not share with the whole sister. The like is true of half uncles, &c. According to this rule 5, however, the purchaser's brother of the half blood on the part of the *mother* does not take next after his brother of the whole blood, for such half brother claims through, and therefore takes *after* (rule 2) the mother, who (rule 4) is postponed to the father.

6. The mother of the more remote male ancestor inherits before the mother of the less remote; and the mother of any male ancestor before the mother. (See s. 8 of the new Act.) Thus the father's mother takes before the mother, and the father's father's mother before the father's mother, &c.

These six rules, read one with another, will, it is believed, point in any case to the heir. It is observable, and in this respect the new differs from the old law, that there cannot be a nearer heir born after the heir who has inherited. Formerly the sister of the purchaser might inherit, and a brother of his be afterwards born, in which case the inheritance *shifted* to the latter. But at present this cannot be, as the father takes before his children (rule 2), and all children in the womb are considered by law as if born. The practical difficulty in finding an heir or proving a title by descent is, not to understand the law, but to ascertain and prove the facts on which the law must operate. (As to this, see Burton's 'Compendium of the Law of Real Property.') The new Act provides against the difficulty of tracing descent from the purchaser, by the enactment that the last owner shall be always presumed to be the purchaser till the contrary is proved (s. 2).

To comment at length upon the rules regulating the course of descent is beyond our limits. Some observations and references are however necessary. Rule 3, which makes the eldest son, brother, &c., sole heir, exclusive of the other children, or the other nephews and nieces, &c., is well known by the name of "the law of primogeniture." It is almost peculiar to our country, not having been observed by the ancients, and being generally abolished where it existed on the Continent and in the United States of America. For the history of this rule, see Hale's 'History of the Common Law;' Sullivan's 'Lectures;' Robinson on 'Gavelkind;' 2 Blackstone's 'Com.;' Wright's 'Tenures;' and for observation on its expediency, Smith's 'Wealth of Nations.' The preference of males to females is not so peculiar. The Jews, Athenians, and Arabians, though not the Romans, gave the inheritance to sons exclusive of daughters. (For the Athenian law of inheritance, see Jones's 'Isæus;' for that of the Jews, Selden 'de Successionibus apud Hebræos.') This is not however the case among most foreign nations at present. The preference of the child of the elder son dead in the purchaser's lifetime to the younger son (which we have endeavoured to show is the necessary consequence of rule 1) has some interesting historical associations. The law on this point seems to have been derived from the civil law, and not to have been settled till after most of the other rules of descent. It was still somewhat doubtful when King John kept his nephew Arthur from the throne by disputing it. (See 2 Bl. 'Com.;' Sullivan's 'Lectures,' lect. 14. In Robertson's 'Charles V.,' vol. i., p. 272, there is a curious story of the trial by combat of this point of law.)

The descent of estates tail (regulated by stat. 3 Edw. I., c. 1) differs from that of fees simple principally in this, that only the descendants of the first donee can inherit; and of these only males claiming exclusively through males can be heirs when the estate is in "tail male:" when it is in tail female (a mode of gift which is quite obsolete), only females claiming exclusively through females. [Entail.] The limited descent of the estates, together with other qualities of them, makes them the best representatives at present existing (excepting indeed copyholds) of the ancient fiefs.

(On the law of descent, as it existed before the late Act, see Sir

Matthew Hale's *History of the Common Law*, chap. xi.; 2 Black. *Com.*, chap. xiv.; Cruise's *Digest*, vol. iii.; Watkins *on Descents*, principally treats of curious points, many of which have ceased to be important. As to the reasons for the new alteration, see *First Report of Real Property Commissioners*.)

DESCENT OF BODIES. [FALL OF BODIES.]

DESERTER, an officer or soldier who, either in time of peace or war, abandons the regiment, battalion, or corps to which he belongs, without having obtained leave, and with the intention not to return.

As the last-mentioned circumstance distinguishes the crime of desertion from the less grave offence of being absent without leave, it becomes necessary, before the conviction of the offender, that evidence should be apparent of such intention. The evidence may be obtained generally from the circumstances under which the deserter is apprehended; for example, he may have been found in a carriage or vessel proceeding to a place so distant as to preclude the possibility of a return to his corps in a reasonable time; or letters may have been found in which an intention to desert is expressed; or some offer may have been made by him of enlisting in another corps, or of entering into some other branch of the service.

The civil courts of law, in this country, have ever had authority to try offenders accused of desertion; but they have long since ceased to exercise such authority, and they now interfere only in the rare case of an appeal from the decision of the court-martial which is held for the purpose of investigating the charge and awarding the punishment. The latter courts are permitted the exercise, to a certain extent, of a discretionary power in proportioning the punishments to the degrees of criminality in the accused; and such a discretionary power is generally considered more likely to promote the ends of justice than the stern rule pursued in civil courts, where, as the jury see no middle course between a certain degree of punishment and entire acquittal, the criminal frequently escapes through their compassion, because the punishment appears disproportionate to the crime.

The practice of deserting from one regiment or corps, and of enlisting in another, either from caprice or for the sake of a bounty, having been very frequent, a particular clause has been inserted in the Articles of War, in order to prevent this abuse. It declares that any non-commissioned officer or soldier so acting shall be considered as a deserter, and punished accordingly; and that any officer who knowingly enlists such offender shall be cashiered. And notwithstanding that such re-enlistment is unlawful, the soldier who afterwards absconds from the corps is punishable as a deserter; and upon any trial for desertion, any desertion previous or subsequent to that for which the prisoner is being tried, if duly stated in the charges, may be given in evidence against him. Any officer or soldier who may advise or encourage another to desert is also punishable by a general court-martial.

Absconding from a recruiting party after having received the enlisting money is, after the expiration of ninety-six hours, declared to be desertion, although such recruit, in consequence of his absence, has not been attested. And an apprentice who enlists, representing himself as free, if he afterwards quit the corps, is esteemed a deserter unless he deliver himself up at the expiration of his apprenticeship. Persons who fraudulently confess themselves to be deserters are liable to serve in any of her Majesty's forces as her Majesty shall think fit to appoint, although such persons have not been actually enlisted as soldiers; or they may be convicted and punished as rogues and vagabonds, or charged with obtaining money under false pretences, and the confession and receiving subsistence as soldiers by such persons are made evidence of the false pretence.

A non-commissioned officer or soldier who simply absents himself from his corps without leave is exonerated from the graver part of the charge, if any circumstances can be adduced from which it may be inferred that the absence was intended to be but for a short time. Such circumstances are: goods of value being left behind; the occupation in which the absentee is found to be engaged being in its nature temporary; an intention of returning having been expressed; or again, the offender suffering himself to be brought back without resistance. Simple absence without leave is referred to regimental courts-martial merely, and these award the punishment discretionally.

The Mutiny Act authorises general courts-martial to condemn a culprit to death, should his crime be found to deserve the extreme punishment; in other cases they may sentence him to a term of penal servitude not less than four years, or to a term of imprisonment, or to corporal punishment not exceeding fifty lashes with imprisonment, and, in addition thereto, the loss of additional pay, or good conduct pay, or pension, to which he might have been entitled.

DESERTS. This word is of very vague signification; it is used generally to designate an uninhabited place, a solitude, and in this sense is equally applicable to the fertile plains watered by the Marañon and the sandy wastes of Libya. It is, however, more exclusively appropriated to sandy and stony plains.

Siliceous sand, to which the term most commonly applies, has been originally produced by the disintegration of the crystalline rocks, or by the mechanical comminution of flint itself, each particle being a fragment of quartz or of flint. Among geological changes always proceeding is the re-aggregation and consolidation of these grains into *sandstone*, which, under the continued action of subterranean heat, becomes metamorphosed into quartz-rock; and this also, in the lapse of ages, may itself become disintegrated, and return to sand again. Sand is of great importance to man, by reason of the fertility which its admixture with clayey soils procures, and by the innumerable uses to which it is applied in the arts. Clays themselves consist of silicate of alumina mingled with silica in a still more minute state of division than that of sand, resulting from the chemical decomposition of felspar, and of other minerals entering into the constitution of rocks. Calcareous sand originates sometimes in the disintegration of limestone rocks, more rarely in the chemical precipitation of carbonate of lime, but most frequently and abundantly, as in much of the sand of the sea and of rivers, in the comminution of corals and the broken shells of mollusks, crustaceans, echinoderms, and other marine or aquatic animals, the hard parts of which consist of carbonate of lime, mingled with the entire shells of foraminifera and minute mollusks. Of this last description of calcareous sand, that of Bermuda is a remarkable example. In many instances siliceous and calcareous sand, and the latter of several or of all kinds, are mixed together. The siliceous is the most permanent, calcareous sand being soluble, and in fact constantly subject to solution, in rain- and in spring-water charged with carbonic acid. The sand of deserts is characteristically (though not exclusively) siliceous, such sand being the most abundant because siliceous rocks predominate in the known crust of the globe, and silica is the most abundant earth in nature.

It was here remarked in this article, as originally published, that "in considering the vast seas of sand which cover such an amazing proportion of the earth's surface, we are tempted to believe that there is too much of it, and that it had been better if in its stead were rich meadows and arable land; but since deserts exist, we must remain persuaded that they are necessary to the general economy of the globe."

But there may be too much of sand, and it may be true that it would be better if in its stead there was land susceptible of cultivation, and yet deserts may be necessary to the general economy of the globe, as it at present exists. We have no *à priori* knowledge of the true order of nature; and, besides, deserts, as we shall presently find, constitute merely one term of the series of forms which the actual surface of the earth has to take during the ceaseless mutations which preserve it in a fit condition for the support of organic existence, and finally of man himself.

A general view of what may be termed the geological philosophy of deserts was given by Dr. Ami Boué, in his explanatory memoir of his geological map of the globe, communicated to the Association of German Naturalists at Gratz in 1843, and read also to the Geological Society of France in the following year, and published in that society's 'Bulletin,' second series, vol. i., pp. 296–371 (Deserts, pp. 326–327). With some corrections and additions, the following statement of this view is derived from Dr. Boué's memoir, as given in a condensed form in Keith Johnston's 'Physical Atlas.'

Among the facts of physical geography of greatest importance towards deciphering the geology of a country, we must rank the locality of *deserts*, or of places where water is rare and vegetation almost or wholly wanting. Deserts, properly so called, infallibly point out districts of the globe into which, at a comparatively recent geological epoch, our present seas were prolonged in great gulfs or straits, or which were occupied by actual *mediterraneans* that have now disappeared wholly or in part, and which gradually changed into fresh-water lakes previous to their escape or entire drying up. [Salt-water lakes, however, have in most cases, if not in all, been an intervening term, and in many instances the only one, as is evident from some of the North African and Persian deserts, among others.] It is, in fact, a physical impossibility that a true desert can expose any *ancient* formation; for every district of that description must sooner or later have been covered by a more modern deposit, more or less fit for sustaining vegetation. It is undisputed that our marine sandy beaches are the only formations now in progress at all identical with deserts; and that it is only the tertiary formation, whether of salt or fresh water, and especially the strata of the arenaceo-cretaceous system, which, by means of the variety of sands, gritstones, limestones, and clays which they include, can originate expanses of sand *interspersed with fertile oases.* These facts suffice to demonstrate the modern origin of deserts in general, and fix, also, in Dr. Boué's opinion, the comparative age of the red and white sandstones of Northern Africa. We deduce, further, he continues, that the formation of a desert presupposes, the vicinity of certain strata or rock-masses, the presence of certain marine currents, and especially a position between great ancient chains of mountains which the water could abrade, in order to form, with the siliceous portions of their structure, either extensive alluviums or strata of sandstone easily disintegrated. To apply these conceptions: we find in Egypt, in Nubia, in Dongola, towards the south of Sahara, in the regency of Tripoli, in Arabia Petræa and Arabia Felix, and in Persia, the inferior cretaceous formation giving rise to moving sands and to rocks of friable sandstone, like those seen at Mans and in Saxon Switzerland; whilst in the rest of Sahara and of Persia, in Egypt, in Mesopotamia, on the banks of the lower Indus, in Central Asia, and Western Australia, the tertiary strata, or even the alluviums, have the chief share in the production of oceans of sand interspersed here and there with saline efflorescences. Other strata or rocks are observed in deserts, on account of the tendency of the moving soil of the latter to invade and cover up everything which does not oppose such domination, either by its elevation above the general level of the plain or by means of its waters; and this is the reason why a variety of rocks have been supposed to be originally connected with deserts, over which they have in reality merely extended their sands derived from the sources already stated. Thus, on the two borders of the Red Sea, granitic rocks, as well as crystalline schists and cretaceous or tertiary limestones, form a constituent part of the soil or substratum of the deserts. This also appears to be the case with some parts of the Asiatic desert of Kobi, and with the few deserts proper of South America, such as that of Atacama, covering crystalline schists. At the eastern base of the Rocky Mountains, in North America, deserts without water have also been produced, it is said, by the disaggregation of sandstones of uncertain age. Still, of course, the sands of deserts must always rest on some other geological formation, like the sandy beaches of the present day.

We proceed from the geology to the physics and meteorology of the subject. Professor Tyndall ('Phil. Trans.,' 1853) having found that there are the strongest experimental grounds for the belief that silica possesses a higher conductive power for heat than some of the metals, and shown that the average conducting power of wood may be taken at 12°, while that of silica is 90° (according to the deflections of the galvanometer employed in his method of measuring that power), remarks that the part played by silica in exercising an influence upon climate has hitherto had no particular importance attached to it; and, having also cited the former conclusions of De la Rive and De Candolle relative to the influence which the feeble conducting power of wood must exert in preserving within a tree the warmth which it acquires from the soil, proceeds to contrast, in exemplifying the functions in nature of silica, two regions overspread with the former and with the latter respectively. "Let us consider for a moment the progress which takes place from sunrise to the hour of maximum temperature in a region overspread with forests, and compare it with that which must take place in the African desert. In the former case, the heat slowly and with difficulty penetrates the masses of wood and leaves on which it falls; and after the point of maximum temperature is passed, the yielding up of the heat acquired is proportionately slow. In the desert, however, the mass of silica exposed to the sun becomes burning hot as the hour of maximum temperature approaches; but after this is passed the heat is yielded up with proportionate facility. Hence a maximum and a minimum thermometer must, in the latter case, mark a far wider range of temperature during the twenty-four hours than the former. This agrees with observation. In Sahara, to use the words of Mrs. Somerville, during 'the glare of noon the air quivers with the heat reflected from the red sand, and in the night it is chilled under a clear sky sparkling with its host of stars.' Were gypsum, however [of which some deserts consist], the prevailing mineral, it is *a priori* certain that this could not be the case to anything like its present extent. . . . . A cube of the latter substance, examined in the usual manner, produces a deflection of 19° only. It is scarcely superior to wood."

Deserts of sand are much more abundant in the Old than in the New World. Almost every plain, even the best cultivated in Europe, contains patches of sand of greater or less extent; but to confine ourselves to *deserts*, properly so called, let us consider the immense surface which they occupy on the ancient continent.

Africa, from its western coast, between the Senegal river on the south and Marocco on the north, to the border of the Red Sea, presents one vast sea of sand, occupying upon an average about 48 degrees of longitude and 10 of latitude, which is but partially interrupted by a projecting part of Fezzan and by the narrow valley of the Nile. This sterile region is divided into two unequal parts; the more considerable, that to the west, being called the Sahara, or Great Desert, and the other, to the eastward, sometimes bearing the name of the Libyan Desert. Both the one and the other inclose a few small fertile spots called *Oases*, which rise in the midst of the sands like islands in the ocean. They serve as a resting-place to the merchants, who, by means of camels, poetically termed the ships of the desert, traverse these dismal regions.

The Desert of Sahara [SAHARA, in GEOG. DIV.] is represented to us as covered with moving sands formed into ridges like the waves of the sea. In the midst of these sands, whose position and aspect are continually changing by the effect of the wind, are dispersed a few rocky hills, and small hollows where the collected waters nourish a few shrubs, ferns, and grasses. The mountains which bound the desert on the west present insulated pinnacles, descending gradually into a plain covered with white and sharp siliceous stones, and which is at last confounded with the sands. At Tegazza, and some other places rock-salt, whiter than the whitest marble, extends in vast beds beneath a stratum of rock.

"During the greater part of the year," says Malte Brun, "the dry and heated air presents the aspect of a red vapour; the horizon seems beaming with the fires of innumerable volcanoes. The rains, which fall from July till October, do not extend their uncertain and momentary benefits to all parts alike. An aromatic herb resembling thyme, the plant which bears the Sahara berry, acacias, and other thorny shrubs, nettles, and briars,—such is the only vegetation which is met with on a few spots in the desert. Rarely is a grove of date-trees or of other plants to be seen. A few monkeys, a few antelopes, content themselves with what little food they can find. The ostrich also inhabits this region in numerous flocks, feeding upon lizards and snails and a few coarse herbs. Lions, panthers, and serpents, often of a monstrous size, add to the horror of these dreadful solitudes. The desert presents no traces of a beaten path, and the caravans that traverse it, directing their way by the polar star, describe a tortuous road in order to profit by the oases, described as brilliant with vegetation, but which probably owe a great part of their reputation to the contrast they form with the absolute barrenness of the desert."

Such is the dryness of the terrible burning wind named Samoom, Samum, or more properly *Samiel*, that it frequently absorbs the water contained in the skins borne by the camels for the use of the merchants and drivers. A last cruise of water has been sold for ten thousand drachmas of gold. In 1805, an akkabah or caravan, composed of 2000 persons and 1800 camels, not having found water in the usual halting places, they all, men and animals, perished of thirst. It is in the desert that is seen most particularly that singular optical illusion termed the *Mirage*. [MIRAGE.]

Desert of the North-East and East of Africa.—The great sandy region, as we have said, is contracted in one place by the country of Fezzan. To the east and south of this are deserts occupied by the Tibboos, a nation of Berbers; whilst on the north-east the desert of Barca, the ancient Cyrenaica, extends as far as the Mediterranean; both these are continued on the eastern side by the great desert of Libya, which borders on Egypt, forming its western boundary. These deserts differ little in character from the Sahara. To the south, the Libyan desert joins the equally sterile region of northern Nubia; leaving which, and crossing the Nile, we again meet with sandy and rocky tracts, which, from Abyssinia on the south as far as Suez on the north, occupy the whole space between the river and the Red Sea.

A comprehensive induction due—we believe originally due—to the late Edward Forbes, has shown that the Mediterranean and the Red seas are the remainder of a former great Indian ocean and south Mediterranean, which extended to the mountains of northern central Africa, prior to the elevation of the eastern portion of its bed, now forming the land of Arabia, Syria, and Palestine; and probably also, it may be inferred, before the Mediterranean depression had been opened to the Atlantic waters on the west. Agreeably to this view, the Sahara and Libyan deserts, as Forbes further showed, occupy the drained though but slightly elevated bed of the western part of this ancient ocean, extending northward from the mountains to the southern shores of the present Mediterranean. As Dr. Bolle has evinced (Hooker's 'Journal of Botany,' 1852, p. 122) that Fuertaventura, the greatest of the Canarian islands, is a Sahara in miniature, we may add that it must also have extended westward beyond the line of the existing African coast into a part of the area now occupied by the waters of the Atlantic.

Deserts of Arabia.—Passing from Africa to Arabia, we first meet with the sandy hills which form the isthmus of Suez, and separate the Arabian gulf from the Mediterranean, whose coast-line they follow as far as Palestine. Immediately to the south of these sands extends the stony and barren tract known by the name of Arabia Petræa. The reputed Mount Sinai, an imposing mass of granite, is there surrounded by rocks of inferior height, composed in part of sandstone, and inclosing a few fertile valleys producing grapes, pears, and other excellent fruits; but the country in general is of frightful sterility, presenting nothing but a few shrubs of Egyptian thorn (*acacia vera*), which furnishes the gum arabic, with capers, and a few other plants, intermixed with rocks of a blackish granite, of jasper, and of sienite, and plains covered with sand, flints, and rolled stones. There are, however, large herds of gazelles and other game.

On the south, as far as Hadramaut, and bounded on the east by the Euphrates and Persian Gulf, and on the west by Hejaz and Yemen, extend the vast deserts of Nejd and Ahkaff, which produce nothing but a few saline plants, and their general appearance differs little from the deserts of Africa, unless it be that they contain many hilly oases adorned with palms and date trees.

Continuing our route towards the Euphrates, we leave on our left that part of the Arabian desert which bears particularly the name of the desert of Syria, which extends northward as far as Haleb, and in the middle of which the traveller discovers the extensive and solitary ruins of Palmyra, the once magnificent residence of Zenobia.

Desert of Mesopotamia.—Having crossed the Euphrates, we find ourselves in the ancient Mesopotamia, so called from two Greek words signifying *between the rivers*, that is, the Euphrates and the Tigris, and which, in the most extended sense of the name, includes Aljezireh on the north, and Irak-Arabia or Babylonia on the south.

With the exception of narrow slips along the two rivers just mentioned, Mesopotamia is a desert still more horrible than those of Africa and Arabia, of which it may be regarded as the continuation. It is covered with burning sands and sterile gypsum. Wormwood and certain aromatic shrubs are the only vegetation, which, covering immense spaces, banish all other plants. The waters of this desert, mostly all saline or sulphurous, give rise to pestilential miasmata, which remain suspended over the desert till, the equilibrium of the air being disturbed, there is formed that pestiferous wind so justly dreaded in Syria and the neighbourhood, and which suffocates any one who has temerity enough to expose himself to its influence.

This desert, occupied by Arabs living upon plunder, is traversed by the caravans which carry on the commerce between Haleb and Bagdad. Its southern portion, or Irak-Arabia, presents, by reason of the proximity of the two rivers, an aspect quite different from that of Aljezireh. That portion of the plain which forms the ancient Babylonia is covered with alluvium, and, like the delta of Egypt, is periodically inundated. It is an immense meadow, requiring only the hand of industry to be covered as heretofore with abundant harvests, and to become once more the garden of Asia.

Deserts of Persia.—Scarcely have we left behind us these dismal regions, still directing our course eastward, and near the 34th parallel of N. lat., when we meet with the mountains of Kurdistan, covered with forests, and intersected by fruitful valleys.

Having scaled this wall, which forms the eastern boundary of the basin of the Tigris and Euphrates, we find ourselves on the high table-land of Persia, where we again meet with extensive deserts, some of them sandy, such as we have already seen, but more generally of an argillaceous soil; and thus it is that the Persian deserts seem to form the transition between those of Africa and Arabia and the Tartarian *steppes*.

In Persia there are five principal deserts, which occupy about three-tenths of the surface of the country. Of these the first is the great salt desert, which separates Irak-Ajemi from Khorassan, and is about 130 leagues long and 70 wide. On the south it joins the desert of Carmania; on the east it unites to the province of Khorassan. Its soil is a stiff clay, whose surface is covered with a saline efflorescence in some places an inch thick; and its vegetation, as in all the high plains of the country, consists of saline plants, such as the *Statice Tartarica*, intermingled with a few patches of pasture. The three other deserts are those of Kiab, of Meckran, and of Karakoum. The desert of Meckran is in Beloochistan. It is bounded on the south by the sea of Oman, and is separated from the desert of Sinde in Hindostan by the Brahouic mountains and the Indus. It does not belong to the table-land of Persia, but to the basin of the sea, of which it forms the northern boundary, or coast line followed by a part of the army of Alexander the Great on its return from India. Its productions differ from those of the Great Desert, and consist of the Indian palm, and the aromatic shrubs of Arabia Felix. The desert of Karakoum is to the north of Khorassan; it is sandy.

Deserts of Grand Tartary.—Descending the Paropamisian mountains which bound Khorassan on the north, and form in that direction the escarpment of the great high-land of Persia, of which the sandy province of Kohistan seems to form the ridge, we enter upon the deserts of Independent Tartary. This country is bounded on the south by the Paropamisus already named, and by the lofty chain of the Hindoo Koosh, of which it seems to be the continuation; on the east by the high mountains which separate it from China; on the north by some ridges, which on the one hand descend from the great Altaic chain, and on the other from the extremity of the Uralian mountains; and on the west by the Caspian. It may be regarded as the north-western declivity of the great central plateau of Asia. It occupies a surface of about 60,000 square leagues, of which the greater half is a desert; for, with the exception of the immediate foot of the mountains and the water-courses, the whole country is condemned to drought and sterility. The saline and sandy plains extend even round the northern part of the Caspian as far as the Don, and, to the east of the Ural, join the steppe of Isim, claimed by Russia.

The country of Khowarezme or Karissum on the south of Lake Aral is now reduced, by causes among which the invasion of the sands is perhaps the most powerful, to the little district of Khiva, which rises like an oasis in the desert, and which a man may ride round in three days.

The greater Bucharia, or Bokhara, is also surrounded by sands to the north and west. The whole of Independent Tartary at the present time perhaps hardly contains a population of five millions,—a proof of the extreme sterility of the soil.

On the south-east of the province of Kohistan, of which we have spoken, is situated Segestan, and the country of the Afghans.

Desert of Afghanistan.—Afghanistan is an extensive country, containing the city of Candahar. [AFGHANISTAN, in GEOG. DIV. It is a vast sandy basin, except in the immediate vicinity of the mountains by which it is bounded on the east and north, and along the banks of the rivers Lhorah and Helmend or Hindamend, which latter traverses it from east to west, and terminates in the Lake Zorah. The land rises on the north-east towards the lofty mountains which sustain the great central plateau of Asia, and from which descend the Indus towards the south-west, and the Ganges to the south-east.

The vast extent of arid deserts which we have just described, scarcely interrupted by the Indus itself, reaches to the very banks of the Hesydrus, the most eastern of the rivers of the Punjab.

From Cape Bojador on the Atlantic to beyond the Indus, the sandy region extends in a curved line of 1400 geographical miles, and, setting aside the fertile oases, is estimated by Humboldt as covering a surface of 300,000 square leagues; and yet, however extensive this tract, which seems condemned to eternal sterility, we have still to consider the great central table-land of Asia, not less arid than what we have just seen.

Deserts of the Great Central Plateau of Asia.—The first country we meet with as we go eastward is Little Bucharia, bounded on the north by the mountain chain of Alak, which separates it from Songaria, and on the south by the Moos Tagh and Great Tibet. On the east it joins Mongolia.

Little Bucharia is tolerably fertile near the mountains, whence descend innumerable streams, which, uniting in the river Yarkand, flow with it into the Lake Lop, having no issue. The whole of the centre and eastern portion of the country is a sandy and salt desert.

Leaving on the north Songaria, which also contains immense arid spots, and whence the river Irtish takes its rise, still continuing our route towards the east, we find the sterile plain extending towards Mongolia, where it opens out to form the vast desert of Shamo, which extends to the Great Wall of China through a length of 500 leagues, rarely interspersed with a few fertile spots.

From the outer slopes of those mountains which inclose and sustain the central plateau, the highest in the world, descend those mighty rivers which, on the one hand, fertilise the great empire of China, and pour the tribute of their waters into the Pacific, and on the other, traverse the widely-extended *steppes* of Siberia to disembogue into the Frozen Ocean.

As for the area of the sandy deserts of the Tartarian table-land, it may on a very moderate computation be estimated at 100,000 square leagues, which, together with the former 300,000 for the African, Arabian, and Persian deserts, and about 100,000 more for the widely-spread sandy and barren tracts in the south of Africa, and sandy patches of Europe, gives a grand total of half a million square leagues of desert in the Old World alone; that is, a surface equal to the whole of Europe, or forty-four times the extent of Great Britain, and this without including the boundless *steppes* of Siberia, or the marshy plains of Northern Asia bordering on the icy sea.

A peculiarity of character in the enormous heat and aridity of the Australian deserts, and which also appears to be extended, though in an inferior degree, to those of South Africa, has a cause purely astronomical—the greater proximity of the earth to the sun at the period of the summer solstice in the southern hemisphere, and winter solstice in the northern; and was pointed out a few years since by Sir J. F. W. Herschel, in his 'Elements of Astronomy' (369), &c. This peculiarity is so remarkable, and would appear to be in its turn the cause of so many phenomena, characterising the physical geography and all the three kingdoms of nature in Australia, that it is requisite to enter more particularly into the subject than might at first sight appear necessary.

For half the year the earth is one-thirtieth part nearer the sun than in the other half-year, and the difference of the sun's direct heating power amounts, in consequence, to one-fifteenth of the whole; but during that half-year, precisely, the earth moves quicker in its orbit, and therefore does not receive any more heat than in the other half-year when it moves slower, at a greater distance from the sun. No inequality therefore exists between the mean temperature of the two hemispheres, but an equal and impartial distribution of heat is accorded to both.

The perihelion of the earth's orbit, however,—the point where the earth is nearest to the sun by 3,000,000 of miles, is nearly at the place of the southern summer solstice, so that the effect of the greater heating power of the sun, owing to the smaller distance of the earth at this particular time, the midsummer of the southern hemisphere, is really to augment the local temperature of places in that hemisphere. This causes the direct impression of the sun's heat in the height of summer, to use the words of the original elucidator of the subject: "The glow and ardour of his rays—under a perfectly clear sky, at noon, in equal latitudes and under equal circumstances of exposure," to be "very materially greater in the southern hemisphere than in the northern.[*] One fifteenth is too considerable a fraction of the whole intensity of sunshine," continues Sir J. Herschel, "not to aggravate in a serious degree the sufferings of those who are exposed to it in thirsty deserts, without shelter. The accounts of these sufferings in the interior of Australia, for instance, are of the most frightful kind, and would seem far to exceed what have ever been undergone by travellers in the northern deserts of Africa."

Facts illustrative of this peculiarity of the Australian deserts, great part of which, in consequence, and on account of their mineralogical constitution, are in the state of compact highly-baked earth, will be found in the relations of their explorers; especially in Capt. Sturt's Narrative of his expedition into Central Australia. He remarks, that the ground was almost a molten surface; and the progress of one of the most recent expeditions is stated to have been terminated by the ground having assumed the condition of the top of a glowing brick-kiln; properly, of a clamp of burning bricks. Capt. Stokes, R.N., has recorded in his 'Discoveries in Australia,' circumstances which evince that the heat acquired from the sun, in the northern regions of the country, is so great, that though the air becomes cooler in the night, from the absence of the solar radiation, the terrestrial radiation, as he observed, is insufficient perceptibly to cool the ground, the heat of which must therefore accumulate until the end of the solstice, and be the immediate cause of the phenomena just noticed. Even at Adelaide, in the province of South Australia, in a higher latitude, the temperature, at the same season, is such as often to threaten, and sometimes to produce, disastrous results; that of the air having been, for example, in February, 1858, for a week or more, at from 110° to 120° Fahr.

---

[*] It must be remembered, that, as if to counteract any possible tendency of this to disturb the general equilibrium or balanced condition of the earth's surface, on which the well-being of the human race and of organic nature in general depends, the *land* being greater in extent in the northern hemisphere, which has its summer solstice in June, the temperature of the whole (as Professor Dove has shown) is greater in that month than it is in December, when the earth is actually nearest the sun.

In South Africa analogous circumstances of weather and terrestrial surface have been observed in Little Namaqualand, half of which is stated to be a dreary waste of desert sand, and the remainder a howling wilderness of lofty rugged mountain chains and peaks, with extensive tracts where no blade of grass or drop of water can be found. Mr. Bell, a recent explorer, though he had travelled in South Africa for twenty-four years, had never acquired, until his recent examination of this region, "any adequate idea of utter desolation." The change of weather was rapid from that accompanying heavy snow up to intense heat; indicating the agency, throughout the seasons, of the same principles, which, as we have seen, govern the diurnal changes of temperature in the deserts of Northern Africa.

The principal desert-plains of America, being of a different character and known by other names, as PAMPAS, SAVANNAHS, &c., are described under their proper heads.

DESICCATION is the operation of drying bodies, and is effected in different modes according to the nature of the substance.

One of the simplest cases is that of drying a precipitate which has subsided in the fluid from which it is thrown down: this may be effected after due washing by transferring it to a glass, porcelain, silver, or platinum capsule, the weight of which being previously determined, that of the substance dried is readily found on weighing. Sometimes substances are dried merely by exposing them to the air; in other cases at a temperature regulated according to the nature of the substances, as at 100° or 212°, in warm chambers, or a sand heat, or at a red or white heat.

The desiccation of precipitates upon paper filters is very commonly effected to a certain extent by absorption, or by placing the filter and its contents upon a piece of chalk or upon a brick; the operation being completed either by exposure to the air, or in any of the vessels and at any of the temperatures above named. In many instances desiccation is performed by means of the air-pump, which is useful in those cases where delicate organic bodies, which would be injured even by moderate degrees of heat, require drying. Mr. Leslie's process consists in placing the substance to be dried (or a fluid to be evaporated) under the receiver of an air-pump, over a basin containing sulphuric acid or some other substance having great affinity for water. The receiver being exhausted, the operation is left to itself. On account of the absence of the air, the moisture is readily vaporised and is quickly absorbed by the sulphuric acid; and the vaporisation and absorption continue till the substance is dry.

Desiccation may be carried on at common temperatures without the process of exhaustion above described; thus a basin containing quicklime with a moist precipitate placed above it, and the whole covered with a jar or receiver, will soon render the precipitate dry. Any deliquescent salt may be substituted in some cases for sulphuric acid or quick-lime; such, for example, as potash, carbonate of potash, and chloride of calcium.

In chemical investigations it is frequently necessary to deprive gaseous bodies of their moisture. The nature of the drying substance employed must depend upon that of the gas to be desiccated: thus ammoniacal gas is absorbed by chloride of calcium, and immediately by sulphuric acid, but potash or carbonate of potash answers well for it. Again, sulphurous acid gas would be absorbed by potash or carbonate of potash, carbonic acid being evolved in the latter case. In fact care must be taken that the desiccator exerts no chemical action upon the substance to be dried.

DESIGN. In the Fine Arts the word design (from the Italian *disegnare*, to draw) is employed in two very different significations. In the first place it is used merely to signify the act of drawing, or representing in lines, the form of any object; in the next place it expresses that combination of invention and purpose which enables the artist to compose a picture or a group, without reference to the material in which it is executed.

The accurate conception of form and beauty is displayed in the most masterly degree in the ancient Greek sculptures; and in the invention of appropriate attitudes, and perfection of physical form, the design of the best Greek sculptors cannot be surpassed. And whilst such works as the marbles of the Parthenon are the safest guides to the young sculptor, they afford also models that cannot be too carefully considered by students of every other branch of art. Of all the existing specimens of painting, the works of the Italian masters display the most consummate excellence in design, especially the Florentine and Roman schools, and among them Raffaelle's in particular. The conception of the story, and the ruling passion of the moment; the selection of forms appropriate to the actors of the story; the invention of appropriate attitudes, not merely for the single figures, but for whole groups, artfully disposed in such manner as to be adapted at once to the freedom of nature and the intention of the artist to assign to each its position according to its prominence in the story; and the perfect execution of the design, placing before our eyes in a palpable shape the inward thoughts of the painter, combine to render the design of Raffaelle's works the most perfect in existence. Michel Angelo's power is more apparent in the conception and execution of forms purely physical, and his design is therefore of a more limited though perhaps hardly less elevated style. A single figure from his unrivalled hand may be contemplated with emotions of admiration and wonder scarcely less than those which we feel when the whole of his greatest work is before us. Raffaelle designed not merely to overawe the spectator with physical vastness, but to elevate him above the visible world. Human suffering, superhuman inspiration, and divine benignity are subjects within the reach of his pencil. These are displayed equally in his cartoons as in his frescoes and oil paintings—perhaps, indeed, even more. [CARTOONS.] The tortured figure of the chastised Ananias, the terrible power inspired into Peter, the prophetic absorption of the apostle near him, pointing with his finger to the source of that power, bring into the design of that one cartoon (the Death of Ananias) the most sublime speculations; and if it be second to the Transfiguration as a picture, it is no less a model of perfection in design,—notwithstanding anachronisms of costume, &c., which it would be absurd in a painter of the present day to repeat.

The student in design may discover the means by which former artists attained their power by carefully studying and thoroughly analysing their works,—namely, the sculptures of Greece and the paintings of the old masters. But it must be study pursued with a view to the enlargement of his artistic powers, not to the accumulation of precedents or the imitation of style. Copying, he must recollect, is at best, as Reynolds expressed it, a delusive kind of industry. He must, however, equally avoid following the implied advice of Reynolds, merely to store his mind with the thoughts of the great masters, and give them forth second-hand as his own. That the greatest poets and painters have borrowed is no apology for an education which recommends only borrowing. To appropriate with justice and effect the thought of another, the borrower must be at least as great as the original inventor. The legitimate object of study, or that part of study which seeks to shorten the process of education, is to discover the mode which other artists have pursued in disciplining their minds, and eyes, and hands, in order to comprehend and express the nature which they had to portray. Art, as has been said already [ARTS, FINE], is creative, not imitative. Every work of Fine Art, to whatever class it belong, is valuable in proportion as it reveals the inner thought, idea, or mental idiosyncracy of the artist; and that course of study, therefore, will be most efficient which prepares the student to give the fullest effect to what he himself has observed in human experience and external nature. The study of the best poets, of histories, and the lives of individuals, of emotions casually displayed in the events of daily life, and in fact everything that helps to teach a knowledge of human nature, and the working of its internal feelings, combined with an accurate knowledge of those external forms which must enter into every composition, will conduce to the development of a power of original design.

DESIGN, IN ARCHITECTURE. Design, together with its meaning of drawing, is often understood to mean the *idea*, rather than the *drawing*, of either a picture or of a building; and people talk of the *design* of either of those classes of art production, as though it meant exclusively the abstract invention, or the original conception, of the artist. There is also a moral sense attached to the word, which is frequently used, in works even which treat exclusively of art, namely, the sense of *intention;* and a man is said to do a particular thing with design, when he does it with a premeditated intention. In the following notice the word will be used exclusively in the primary sense, or that of an equivalent to the art of drawing, as applied to architecture or engineering; the secondary sense will be referred to hereafter under the head INVENTION; and the illustrations to be given will have special reference to the practice of engineering and architectural works.

The scheme, idea, or, as it is more usually termed, the design, whether for an intended building or that of one already erected, is usually shown by means of a series of diagrams or drawings, which, being exact geometrical representations, are therefore too technical and formal to satisfy those who look at them as pictures, besides being likewise in some degree imperfect as separate representations, yet, taken one with another, convey a much more exact and complete notion of the whole, both internally and externally, than can be obtained by any other mode of delineation; because they not only exhibit the actual forms and dimensions as they really are intended to exist, and not merely as they would appear to the eye according to the situation of the spectator; but they also reveal the whole anatomy of the fabric, together with many particulars that are concealed from view in the edifice. Such drawings consist of *plan*, *elevation*, and *section*, besides other *details*, or *parts at large;* and their number will depend either upon the nature of the building, that is, on its being more or less complex, or as it is intended to show it more or less fully.

Although a certain prejudice exists against such drawings, on the score of their being too technical and difficult, they become, when once explained, intelligible enough to any person of common capacity, however ignorant he may be of architecture. To begin with the *plan* (the *plant*, or *plot*, as it is sometimes termed by old writers), as the first in natural order, it being that which must be determined upon before the walls can be raised. The plan may no less briefly than clearly be described as the map of the building; consequently, any one who understands geographical or topographical plans of that kind can be at no loss to comprehend the nature of an architectural one; the latter being a far more exact and less arbitrary and conventional representation than the other class. By means of the plan we distinguish most clearly the exact shape and extent of the building as regards the space on which it stands; the thickness of the walls, the internal arrangement, with the forms, number, and areas of the rooms and passages into which it is divided; and the situation and width of the doors, windows, fire-places, staircases, &c.; the solid and raised parts, such as walls, columns, piers, &c., being shaded, and the voids or apertures in the walls, such as doors and windows, being left plain. For every story of a building there must be a separate plan, although it is not usual in books of designs to give more than those of the ground-floor and the principal floor, above it, from which the arrangement and size of the rooms above them may be tolerably well guessed at, unless there should happen to be some uncommon deviation in such respects from those below. Plans may further be distinguished as simple or detailed: the former are mere *floor-plans*, indicating no more than belongs to the floor and walls, while the latter describe, by means of dotted lines on the floor, the projection of cornices, the compartments of ceilings, or the groining and coffering of those which are vaulted or arched; likewise domes and skylights. Or else, instead of expressing what belongs to the ceiling plane, a plan of this kind is made to indicate the pavement of floors, the situation of statues, sideboards, bookcases, and other pieces of furniture, particularly of beds in sleeping-rooms, the position of which is of material importance. Sometimes, too, plans are given showing the exterior of the roof of the building, with its chimney-stacks, gutters, skylights, dormer-windows, parapets, &c.

Another species of plan is that termed a *block-plan*, namely, a map displaying the general mass of the building, together with its locality, either in regard to other edifices or not, as the case may be; and such plans are an exceedingly useful accompaniment to those already described, because they serve to make us acquainted not only with the structure itself, but with its situation. From a ground-plan alone, for instance, of St. Paul's, all that could be learnt in respect to the last-mentioned circumstance is, that it is insulated, whereas a block-plan would show the precise form and extent of the surrounding area; how confined and irregular it is, and how far it would be necessary to set back the houses in some places in order to reduce the whole to uniformity. Plans of this kind are, in fact, *special* maps laid down upon a larger scale, and therefore more exact and detailed, although less comprehensive than ordinary ones.

An *elevation* (formerly termed an "upright," in Italian *alzata*, in German *aufriss*) may be described as a vertical plan, showing the front or one external face of the building as raised upon the plan; it therefore gives the precise forms and measurements of every part, delineated geometrically according to scale, and not as they appear according to distance or the accidents of perspective, whether depending on the level at which the eye is placed, or as the building happens to be viewed parallelly, or more or less obliquely. When the elevation is a single general plane, as is the case, for example, with the Travellers' Club House, in London, it will not differ very much from a direct front view, the projections being only those of the cornice, the dressings of the windows, &c., which are rendered manifest, and may be measured from their profiles; consequently, an eye unaccustomed to such drawings cannot be puzzled. It is necessary, on the contrary, that a person should understand the principle of geometrical drawing before he can form a correct idea of the subject, and judge what its actual appearance would be, if it consists of several planes or separate elevations placed one by the side of the other, all standing upon the same line, and without their returns or the planes perpendicular to and connecting them together, being shown; because, unless the plan is also seen, the shadows alone serve to indicate what parts project and what recede beyond the general line of the front, and in what degree they do so, the shadows being at an angle of 45°, whereby they are made equal to the projection of the part which occasions them, beyond the plane or surface they are thrown upon. This may be easily exemplified by St. Paul's Cathedral: in a geometrical elevation of the western front, the shadowing informs us (without referring to the plan) that the columns in the centre are at some distance from the wall behind them, yet do not form a projecting portico (or porticoes, one above the other); for that would cast a shadow from itself on the building; but that the parts behind the columns recede inwards. Again, we should perceive the whole of the cupola just as if it were immediately over the front, and *between* the two western towers. The only thing to indicate the contrary is, that the shadows would be less forcible, and a tint would be thrown over it, by way of expressing distance; and although, independently of that, no architect would imagine it to be so placed, yet it would be impossible to determine the precise distance from the front, there being no shadow cast upon it by any other part of the building. Consequently, this would remain to be ascertained, either from the ground-plan or from a lateral elevation of the building, in which the cupola would be shown above the transept. One particular in which elevations differ materially from other drawings and from the appearance of the objects themselves, is, that no distinction is made between curved horizontal lines and straight ones: so that whether the part be a plane or curved surface, can be understood only from the shadowing, unless there happens to be something that assists in denoting curvature of plan. Thus, the mouldings of the base of a column are all straight lines; consequently, without shadow to express rotundity, we could not determine whether they belonged to a flat or round surface, unless the shaft be fluted, in which case the flutes will diminish in width, according to their distance from the centre, as may be seen by referring to the cuts in the article COLUMN. So likewise, in respect to a tower without either apertures or vertical lines regularly placed, we cannot judge whether it be circular or not; whereas, if there be either of those descriptions of lines, they suffice to show that the surface is curved, although represented only in outline; because the apertures and the spaces between them would become narrower in proportion as they are more distant from the centre, and their *reveals*, or inner surfaces, would appear. Still, without shadow, we should not know whether the surface was convex or concave, except by referring to the plan, or by the nature of the subject, there being no difference between the two as regards outline alone. This will be obvious when it is understood that the elevations of curved surfaces are projected, as it is termed, from their plans, by lines drawn perpendicularly to the geometrical plane of representation, which determine where the vertical lines to be shown in the elevation will fall, and the distances between them; consequently, whether the elevation be projected from a convex or concave plan, the result will be the same. When no curved parts occur in the elevation, the process just described is superfluous, because the measurements may be taken at once from the plan. The same method, however, it should be observed, is employed for polygonal figures as for circular or curved ones. Thus, of an octagon three sides would be shown in elevation: yet, although of the same width, the two diagonal or oblique ones will appear narrower than that seen directly in front; and the same applies to all oblique surfaces, let the angle they are placed at be what it may; and to such likewise as are oblique to the horizon as well as to those which are vertical. Hence a roof terminated by gables or pediments at the ends of the elevation will, as regards outline, be drawn as an upright plane, and the sloping lines of the pediment will appear vertical.

Notwithstanding, however, these circumstances, which are apt to perplex those who are prejudiced against geometrical drawings because they are not satisfactory as "pictures," a person at all accustomed to them is so far from being in danger of misconceiving them, that it would require an effort on his part to imagine the objects other than what the drawings are intended to express—to fancy a semicircular projection to be a plane, or the profile of a pediment to be upright.

Nevertheless, although the whole may be perfectly well understood, it is not always that sufficient allowance is made, even by architects themselves, for the great difference which sometimes occurs between an elevation and the building itself; or that the real effect is duly considered beforehand. Recourse is therefore occasionally had to what is termed a *perspective elevation*—a kind of conventional representation, partly geometrical, partly perspective, and combining in some degree the advantage of both modes, although strictly neither of them. As in elevations of the usual kind, the building is shown exactly parallel to the picture, with the point of sight precisely in the centre, at the proper height from the ground, and as far as regards the first or principal plane, is treated as any other geometrical drawing; but the parts beyond this plane are thrown into perspective so as to show the sides of projections, the soffit of entablatures, the ceiling and pavement within porticoes, and how much of a dome or other part of the structure, standing back from the front, would be concealed from view, at a given distance. It may be further observed, that elevations, both those of the above description and such as are strictly geometrical, have very frequently a pictorial character given them, not only by colouring as well as by shadowing, but also by the addition of sky and background. Yet it would be better were such accompaniment no more than what is just sufficient to relieve the building, instead of being extended over the whole drawing, and carefully worked up; because it is calculated to seduce the eye, while, by making too great pretensions to the character of a picture, it causes the elevation itself to appear offensively formal and unnatural. In fact, *outline* elevations (which mode is now generally adopted in modern architectural publications, especially foreign ones) are preferable to those which are shadowed, as they exhibit all the forms more distinctly, and admit of being measured with much greater exactness. They do not, indeed, convey any notion of effect; yet that may very well be dispensed with in such drawings, particularly if they be accompanied with perspective views.

We now come to speak of *sections*, which are for the interior what elevations are for the exterior of a building. A section or profile (in French *coupe*, Italian *spaccato*, German *durchschnitt*), is a plane cutting through the structure on some line of its plan, and showing the thickness of the walls and floors, the heights of the rooms, the forms and profiles of ceilings, whether plain or decorated, flat, coved, or arched; also the exact forms of domes and skylights. In fact it exhibits all the separate elevations of the rooms intersected by such plane, that is, the elevation of that side of them which faces or lies behind the plane of representation. In addition to the particulars just enumerated, we are by this means made acquainted with a variety of others, in regard to which a plan cannot be made to afford any information. The thickness of the walls may be ascertained by the plan as well as by a section; so also might the height of the rooms be expressed in the former by means of figures, as the other dimensions generally are; and the form and size of the windows may be learned from the elevations; still we should not know what are the heights of the doors, how they are pannelled and decorated, nor what is the form of the chimney-pieces, &c.; nor be able to judge so well of the general proportions of the apartments. Besides which, sections may be made to show much more than what belongs to the architecture alone, for there are many instances in which furniture, pictures, and other decorations and fittings-up, are introduced; and unless this be done, a section is apt to have a naked appearance, except the architecture itself be particularly interesting and rich. For detailed and filled-up sections it is usual to employ outline, with the walls and floors shaded, the former as more solid being made much darker than the latter. When, on the other hand, the elevations of the rooms themselves are shadowed, the thickness of the intersected walls, &c., are left white, in order to prevent confusion and exhibit the profiles better. It should be observed, too, that in sections of this latter description, it is the practice to throw a shadow from the side walls and ceilings of the rooms, as if it were a model of the building really cut through; thus producing an effect both disagreeable and unnatural, and by no means assisting towards rendering the representation more intelligible. Indeed indispensable and interesting as they are, sections are a far more conventional mode of drawing than elevations, because they represent a building as it never can be seen at all, except where the front of a house has been taken down for the purpose of rebuilding it, while the floors and partition-walls are left standing; in which case any one may obtain a good idea of the nature of a section, but of one seen in perspective. Besides general sections showing the whole of a building from top to bottom, there are frequently partial ones, showing only the rooms on one floor, or even a single room, when it is desired to show it on a larger scale than could conveniently be done any other way. Or instead of this, recourse is sometimes had to a plan of the room with each of its elevations or sides drawn around it, as if laid down flat on the ground, by which means the whole of the apartment is described; for the ceiling may be represented on the plan itself. Horizontal sections again are occasionally made use of, in order to show more accurately than can be done upon a plan, not only the ceiling and its ornaments, but the soffits of entablatures, of window recesses and door-cases, also the capitals of columns and their projection.

Although not in general use, there are likewise many other modes and combinations which deserve to be pointed out. One of them is that of elevation and section united; that is, one half the drawing shows half the elevation, which, as far as understanding it, fully answers the purpose of an entire one; while the other half shows half the section. Another is that of *sectional perspective view*, which, while it serves the purpose of a section in regard to showing the exact form, profiles, and measurements, on the first plane, intersecting the structure, gives also a picture of its interior just as it would appear in any other drawing of the kind; the only difference being, that in this case the drawing extends beyond the interior, while in other views it is bounded by and confined within it. It is hardly necessary to observe that such a mode is suited only for showing a single space, and not one divided into separate rooms. It is exceedingly well calculated for displaying the interior of a portico, as it admits of the situation of the columns in front being shown by the foreground being made a *perspective plan*.

Besides the usual plans, elevations, and sections, there must likewise be *details* or *parts at large*, answering in some respect to what are termed working drawings; since without these we judge only of the general design, but not of its minutiæ and finishing, whether belonging to decoration or construction:—and far more may be learned, and that too more satisfactorily, by studying a single good example thoroughly, than by looking at many which are only imperfectly described. It is therefore to be regretted that published designs, unless they happen to be those of actual buildings, are so exceedingly defective in this respect, generally showing no more than a couple of plans with one or two elevations, while, although so very essential, sections are entirely omitted. In order to illustrate a subject properly, not only should there be a plan of every floor and an elevation of every side, but sections, both longitudinal and transverse, and as many of each as the nature of the plan may require.

Having done thus much to show the whole anatomy of the structure, we may then provide perspective views both of the exterior and principal parts of the interior, in order to show the character and effect, which, without such drawings, can be judged of only piecemeal, and inadequately even by those who perfectly understand the others. Yet however satisfactory as a representation, a perspective view of an interior must still leave much to conjecture, as one of the sides or ends of it cannot possibly be shown, while of the others two will be more or less foreshortened, so that if there be deep receding parts in them, they can be but imperfectly seen,—perhaps may be quite misunderstood; or can be well understood only by the aid of plan and section. In many cases, therefore, an interior would require two or even more perspective drawings in order to show it completely. But with every part of the building thus fully made out and described in drawings, the whole may be understood as well, in some respects even better, than by a model of it; for besides that the latter can do very little towards showing the interior—certainly not its effect,—there is this drawback attending it, that it conveys no idea of situation or locality, and that, instead of the eye being confined either as to due distance or height, it views it from points from which the building itself can never be seen under any circumstances. Neither has it the accompaniment of sky, background, foreground: a model exhibits the mere building alone—as it is, certainly, yet not as it appears; for it is seldom any attempt is made to give the proper local colouring—at least to do more than merely hint at it. By means of perspective views, on the contrary, provided they be sufficiently numerous and judiciously chosen, and not deceptively embellished with effects of rare occurrence, we may obtain a most accurate idea both of the architecture and of all its local accompaniments and accessories, whether favourable or the contrary. Of *bird's-eye* views of buildings we have said nothing, both because they are now seldom made use of, and because we consider them not only most awkward, disagreeable, and unnatural representations in themselves, but as altogether superfluous, if a building is properly described by the other modes, or even by a block-plan and elevation alone.

DESIGN, SCHOOLS OF. [SCIENCE AND ART, DEPARTMENT OF.]

DESPOTISM. [MONARCHY.]

DETACHMENT, in military affairs, is a portion of an army or body of troops detached and sent on a particular service. It may consist of thousands of men, cavalry, artillery, and infantry, or a small portion of a company. The former description of detachment, namely, one that will materially weaken the main body of an army, has often been made with good results, and more often with bad ones; it is in fact one of the most difficult and dangerous problems of strategy, depending, as it does, for its success in many cases on the fortuitous concurrence of many eventualities, the non-foreseeing or reversal of any one of which may upset the best laid plan for the co-operation of the main body and its detachment, and allowing each to be taken in detail, lead to the most disastrous results. Jomini, in his 'Précis de l'Art de la Guerre,' treating this as a mixed operation which partakes at once of strategy and tactics, has laid down very clearly nearly all that can be said on the subject, and to his work the reader is referred, as the following article can only pretend to exemplify some of the most open advantages and defects of detachments.

A general is so often compelled by necessity to make detachments, and on the proper handling of them so much depends the success of a campaign, that one cannot but consider this one of the most important and delicate operations of a campaign. "En effet," says Jomini, "si rien n'est plus utile qu'un grand détachement lorsqu'il est fait à propos et bien combiné, rien n'est plus dangereux quand il est fait d'une manière inconsidérée." The very employment at all of a detachment, except in those cases where it is meant to rejoin and co-operate with the main body at the critical moment of a general action, appears to be contrary to the cardinal principle of strategy and tactics to act with superior forces on the decisive point, and yet there are circumstances under which they are indispensable. The general employment of detachments may be classed under the following heads:—

1. The employment of great detachments, almost separate armies, not in the principal zone of operations, but with the object of creating diversions on more or less essential points. This seems the most indefensible use of detachments, one in which English forces have often been employed, and which, against a great general, such as Napoleon, were utterly thrown away; for instance, in 1805, Napoleon occupied Hanover and Naples. An English and Russian army was formed to drive him from Italy, and an English, Russian, and Swedish army to operate in Hanover. Nearly 60,000 men being employed in these two detachments, Napoleon, disregarding them, ordered St. Cyr to join Massena on the high Adige, where, based on the Adige and Mincio, and in a very strongly fortified position, he was to oppose the Archduke Charles, whilst Bernadotte quitting Hanover joined him in time to take part in those overwhelming operations about Ulm and Austerlitz, after which Italy and Hanover were easily retaken. On the other hand, a detachment of this description would, in the civil wars of 1793, Jomini considers, have produced decisive results if thrown into La Vendée.

2. Large detachments in the zone of operations to cover important points, to carry on sieges, to mask fortresses, or to protect lines of operations.

These may be termed permanent detachments, acting perhaps during a whole campaign in their own zone of operations. There are again temporary large detachments formed for any of the following special objects bearing immediately on the grand objects of the campaign:—

1. To act on the lines of operation of an enemy and oblige him to retire, or, if retiring, to cripple his retreat.

2. To keep in check or retard the junction of a large detachment of the enemy with a smaller force, and thus allow an overwhelming force to be thrown on the decisive point, or to protect the junction of a detachment.

3. To seize or protect a large convoy, as was effected before Pultowa by Peter the Great against Charles XII., whose detachment of protection lost its way, entailing the loss of Lowenhaupt's convoy, thereby entailing his defeat.

4. To draw off an enemy's attention while an operation is being effected in a different direction, or to mask a fortress and contain its garrison for a short time. Thus Moreau, in 1800, while he himself marched on Stockach, deceived Kray by sending his left wing from Kehl to Rastadt, which then rejoined him by Fribourg.

5. A detachment made almost on the field of battle to act on the flank or rear of the enemy, as at the battle of Vittoria, where the troops under General Graham, though under very unfavourable circumstances for unity of action, from the difficulty of the ground, yet managed to co-operate with great nicety.

However enticing and important these various objects may appear to the general of an army, history has proved that the success of a campaign never depends on such isolated and secondary events, but on the grand decisive actions, or, as at Ulm, merely manœuvres about the decisive point. Hence, it follows that when these approach, exertion should be made even to the running some risks to recall and concentrate the whole available forces. A good example of this is given by Jomini. In 1797, Napoleon, obliged to leave a corps of 15,000 men in the valley of the Adige to contain the Tyrol while he advanced on the Noric Alps, preferred making this corps rejoin him at the risk of compromising for the time his line of retreat, to affording the opportunity, by leaving his army disunited, of having them beaten in detail. Persuaded that he would be victorious with his army united, he considered the temporary presence of some detachments of the enemy on his communications of little moment.

Small flying detachments, whose absence does not materially reduce the strength of an army, do not however come under this category; they may and have often been employed with great advantage, when under intelligent daring officers, partisan leaders, and more especially with irregular troops, whose presence with the army itself would be of little use. The guerillas in the Peninsula afford a good example, entailing endless annoyance to the enemy in cutting off convoys, intercepting orders, and reducing his available forces by compelling him to use large bodies of men in these harassing duties.

DETERMINATE, a word applied in mathematics to those problems which have one answer only, or at least a certain and finite number of answers. Thus the problem, "given the base of a triangle, and the sum of the other two sides, to construct the triangle so that its vertex may be on a given straight line," is determinate; for the number of ways of solving it cannot exceed two. But if we omit the condition that the vertex is to be upon a given straight line, and merely require that a triangle shall be constructed having a given base, and two other sides of a given amount of length, the problem becomes indeterminate; that is, has an infinite number of solutions. The peculiarities of this subject—namely, determinate analysis—are not striking; it is to the word INDETERMINATE that we must look for the most characteristic points of distinction.

DETINUE is the form of action prescribed by the English law for the recovery of goods and chattels which have lawfully come into the possession of a defendant either by delivery or finding. It does not lie for real property, but for mere personal chattels, except only deeds and charters. [CHATTELS.] In this action the plaintiff recovers either the thing detained, or if the thing cannot be had, the value of it, with damages for the detention. In order to enforce the redelivery of the specific chattel, a special writ of execution has been provided, by the Common Law Procedure Act, 1854. The action of detinue is similar to the actio depositi of the civil law, and is identically the same in its properties, process, circumstances, and forms as the action of debt, with this difference, that one is for the recovery of a chattel, the other of money. In order to ground an action of detinue, which is only for the detaining, these points are necessary: 1. That the defendant came lawfully into the possession of the goods. 2. That the plaintiff have a property. 3. That the goods themselves be of some value. 4. That they be ascertained in point of identity.

DETONATION is a chemical term employed to express combination or decomposition which occurs with noise and frequently with combustion. It may take place between bodies in very different states, as between gaseous bodies, a gas and a solid, &c. One of the simplest and most powerful cases of detonation is that which happens when two volumes of hydrogen gas and one volume of oxygen gas are mixed, and fired either by the taper, electricity, the action of spongy platinum or sudden compression; in this case the detonation is loud, and the result of the chemical action is water formed by the union, in the proportions stated, of the gases above mentioned.

The sun's rays falling suddenly on a mixture of hydrogen and chlorine gas cause them to detonate and combine with the formation of hydrochloric acid. Detonation also occurs when phosphorus, mixed with chlorate of potash or with nitrate of lead, &c., is struck upon an anvil. And there are certain combinations of metals which detonate or fulminate, by slight friction, by heat, or by electricity; such are the ammoniurets of silver and gold, fulminate of silver and of mercury. The chloride of nitrogen and the iodide of the same element are very powerful detonating bodies. In some cases, as has been mentioned, the result of detonation is combination, as when oxygen and hydrogen unite to form water, chlorine and hydrogen to form hydrochloric acid, &c. In other cases decomposition occurs and is the result of detonation. Thus ammoniuret of gold is separated into metallic gold, and other products; iodide of nitrogen separates into its elements, the iodine appearing as a purple vapour, and the nitrogen assuming the gaseous form.

DETRUSION, FORCE OF. [MATERIALS, STRENGTH OF.]

DEUCA'LION, a prominent personage in the mythical traditions from which Greek history sprung up. He is represented as the son of Prometheus and Clymene (Schol. Pind. 'Olymp.' ix. 72), or of Prometheus and Pandora (Strabo, ix. p. 443, and others), and is sometimes called the father (Thucyd. i. 3), and sometimes the brother of Hellen (Schol. Apollon. iii. 1086), the reputed founder of the Greek nation. The seat of his authority was Phthia, in Thessaly, from which, according to general tradition, he was driven to Parnassus by a great deluge (Apollodorus, i. 7, § 2), which, however, according to Aristotle ('Meteorol.' i. 14), occurred between Dodona and the Achelous. But whatever may have been the scene of Deucalion's deluge, the old traditions represent it merely as a local one; and it was not till the time of Ptolemy Philadelphus, when the Hebrew scriptures became known to the Greeks, that some features borrowed from the universal deluge of Noah were incorporated into the story of the Thessalian flood. (See Clinton's 'Fasti,' vol. i., p. 43, note.) The legend is well known to the readers of Ovid ('Metam.' i. 375, foll.), which tells how he and his wife Pyrrha repeopled the wasted district by throwing stones behind him on Mount Parnassus, in obedience to the injunctions of the oracle of Themis, which directed them to cover their heads and cast the bones of their mother behind them. Strabo says that two small islands on the coast of Phthiotis were called Deucalion and Pyrrha. The date assigned to Deucalion by the Parian Marble is 1548 B.C., and by Eusebius 1541 B.C.; but the stories connected with his history are so manifestly fabulous, that doubts as to his actual existence are unavoidably entertained, and it seems reasonable to conclude that he was a mere personification. It must be confessed that there are no etymological grounds for thinking so, as appears to be the case more or less with the early kings of Attica ('Philolog Mus.' ii., p. 345, foll.), for the name Deucalion seems to signify nothing more than "the illustrious" (Hesych. sub v. δευκές), and is a possible name for a real person; it was also borne by a son of Minos II. (Apollod. iii. i. 2.)

DEUTERO'NOMY, the fifth book of the Pentateuch, or five books of Moses. The Hebrew title אלח הדברים. ēlleh haddevarim, "These (are) the words," consists as usual of the commencing phrase, a mode of appellation similar to that adopted in technically quoting a legal instrument. Among the Rabbins it is also called *sepher tuckhuth*, "the book of reproofs," or "denunciations," of which there are many, as in chaps. iv. ix. xxviii. xxx. xxxii; and *Mishneh hattorah*, the repetition of the law, a restatement being made in this book of the Mosaic laws contained in the preceding books of the Pentateuch. The Greek title *Δευτερονόμιον, deuteronómion*, given in the Septuagint translation, is composed of two words signifying "second" and "law." By the Jews this book is divided into ten paraschioth, or chapters. In the translations the number of chapters is thirty-four. The events directly related by the writer are comprised in a period of five lunar weeks, from the commencement of the eleventh month to the seventh day of the twelfth month of the fortieth year of the wandering of the Israelites in the wilderness, after their departure from Egypt. The book is generally considered to have been written A.M. 2553, or 1451 B.C., by Moses, in the last year of his life, when at the age of 120, and in the plains of Moab (i. 5; Numbers xxxiii. 50, xxxv. 1), near the ford of the Jordan, where the Israelites afterwards crossed over into Canaan. The opinion which attributes the authorship of this book to Moses is attended with some difficulties which have induced Eichhorn and other learned commentators to assign a much later date to it than the age of Moses. These have been ably met however, and the numerous notices of nations with whom the Israelites had come in contact, but who subsequently disappear altogether, afford strong indications of the Mosaical origin of the book. The concluding chapter, which gives an account of the death of Moses, and of his having been buried by God, is believed by most but not by all of the commentators to have been not written by Moses, for some considered this account as a prophetic one, related in the past tense, a practice not unusual among the Jewish prophets. This last chapter is supposed by others to have been jointly or rather successively supplied by Joshua, Samuel, and Esdras. Besides an historical repetition from the preceding books of the Pentateuch of the events which passed throughout the forty years from the departure from Egypt, the book contains a complete recapitulation of the moral, ceremonial, and judicial law, exhibited in the preceding books of Exodus, Leviticus, and Numbers, with alterations, and some additions; as, for instance, that of the law (xxi. 18) which requires the parents of a stubborn son to lead him forth to be stoned to death by his fellow citizens. The first thirteen verses of chap. xxviii. proclaim the blessings promised to the observers of the the law, and the fifty-five following verses recite the curses on the disobedient. The last twelve verses of the xxvii.th chapter contain the twelve curses which serve to compose the Commination of the English Liturgy. The passages in chap. xviii. 15, 18, 19, are considered as prophetical of the Messiah, on the authority of Acts iii. 22, 23; and vii. 37. Chap. xxxii. consists of the last song of Moses, the poetry of which, in the opinion of a very competent judge, Bishop Lowth, is singularly magnificent. Dr. Adam Clarke remarks, that "very few parts of the Old Testament Scriptures can be read with greater profit by the genuine Christian than the book of Deuteronomy," which is to be considered as correlative with St. Paul's Epistle to the Hebrews. In Wilson's 'Archæological Dictionary,' article *Law*, a valuable tabulated exhibition is given of the whole Mosaic Law, in three classes, moral, ceremonial, and political, with the places of references to Exod., Levit., Numb., and Deut. Dr. Adam Clarke concludes his commentary on the book with six elaborate chronological tables, for which he deserves the thanks of every biblical student. The 'Biblioth. Brit.,' by Watt, contains a numerous list of sermons and commentaries on Deuteronomy.

(Eichhorn's *Einleitung in das Alte Test.*, abtheil ii.; Poli, *Synopsis Criticorum*, tom. i.; Calmet's *Dict.*; Horne's *Introduc.*, vol. iv.; *Horæ Mosaicæ*, by Rev. G. Faber; *Lectures on the Pentateuch*, by Dr. Graves; *Comment. on the Mosaic Laws*, by Michaelis, trans. by Dr. Smith.)

DEUTOXIDE. A chemical term applied to compounds of oxygen, containing two equivalents of oxygen to one of some other body. It is synonymous with *binoxide*. [CHEMICAL NOMENCLATURE.]

DEVASTAVIT. [EXECUTOR.]

DEVELOPMENT. (Algebra, &c.) A name given to the process by which any mathematical expression is changed into another of equivalent value or meaning, and of more expanded form. It is not to be understood that development either facilitates the calculation or the explanation of an expression, necessarily; it may sometimes do the one, and sometimes the other, but as often it is the reverse. Nevertheless, the mathematical use of an expression is frequently facilitated by employing its development, and this in a great variety of ways.

The expressions of common algebra will frequently furnish instances of this. Let us take the development of $(x+y)^3$, namely $x^3+3x^2y+3xy^2+y^3$. The original expression implies an addition and two multiplications, while the development involves six multiplications as difficult as those of the original, two of a more simple character, and three additions. Nevertheless the BINOMIAL THEOREM, of which the preceding is a particular case, is the foundation of many important branches of algebra. But the usual form of development is into infinite series [SERIES], a subject of peculiar interest, and the higher points of which, as may readily be seen from comparison of mathematical writings, are not perfectly well settled.

The mere word development suggests only one question, namely, what connection exists between the expression itself and its development. Are they both actual representations of the same arithmetical value? Or do they merely represent algebraical forms which have the same properties? There are cases in which the first question must be answered in the affirmative, and others in which the second question must be so answered, while it is palpably the contrary with regard to the first. Without entering into the reasons of such difficulties, it must here suffice to remind the student who seeks for such matter as is immediately connected with the common use of the word, that he must be cautious what he admits upon any point connected with it, since it may frequently happen that he will find himself endeavouring to reconcile a very narrow meaning of the term with the forms of expression used by writers who take for granted a knowledge such as can only be acquired by considerable experience and reflection. So wide is the modern use of the term, that the following caution may frequently be useful. When an author speaks of the development of an expression, remember that he may have so extended a signification of the word, that the student should consider him as meaning merely "algebraical substitute," or an expression which may be used for the original without change of algebraical properties. He will hardly understand what we mean, nor is it for our present purpose necessary that he should do so: our intention will be answered, if, in referring to this work for the use of this particular term, he should be distinctly made to understand that in all probability his difficulty arises from an indistinct view of the meaning of equality, or of the sign $=$, as employed in algebra, such as we conceive a very eminent modern English writer to have had, when he proposed, in order to overcome the difficulties attending the interpretation of a series, to consider *one plus one* as having a meaning distinct from *two*.

There are two points connected with developments which it may be worth while to point out, as illustrative of this (at first sight) apparent want of connection between an expression and its development, which it should seem ought to exist between two forms which are used indifferently each for the other.

1. An expression may preserve an algebraical identity with its development in cases where arithmetical identity is entirely lost. Let us consider the series $P=1+x+x^2+\ldots$ continued without end, of which it is an evident property that $P=1+xP$. And the same is also a property of its well-known equivalent form $1\div(1-x)$, which is in truth nothing more than the value of P derived from the last equation. But suppose that $x=2$, and there is no imaginable arithmetical connection between $1+2+4+8+\ldots$ continued for ever, and $1\div(1-2)$ or -1. On this point, see INFINITE, DIVERGENT, and SERIES.

2. A development may present an intelligible result in cases where the original expression altogether loses meaning. Thus, let the following expression be considered: "the product of all whole numbers, beginning with 1 and ending with x," of which 1.2.3.4.5, or 120, is a particular case. Considering this as a function of x, it is obvious that we can find meaning and value in all cases in which x is a whole number. But when x is a fraction, we lose all idea of meaning: what is implied, for instance, by the product of all whole numbers up to $10\frac{1}{2}$? Nevertheless, when we take the approximate expression for this product mentioned in COMBINATIONS, or the series of which it is the first term, namely,

$$\sqrt{2\pi x}\left(\frac{x}{\epsilon}\right)^x\left(1+\frac{1}{12x}+\frac{1}{288x^2}+\ldots\right)$$

the difficulty has disappeared: this series is as easily intelligible and calculable when x is a fraction as when x is a whole number. This paradox—namely, an alteration of form, giving more meaning to an expression than it had at first—is of a character which cannot be briefly treated.

The inverse word to development should be *invelopment*; so that while we say that $1+x+x^2+\ldots$ is the development of $1\div(1-x)$, we should also say that the latter is the *invelopment* of the former. But the latter term is never used, which frequently gives rise to a circumlocutory and sometimes to a defective mode of description.

DEVICE, an emblem or ensign, formerly borne on shields or embroidered upon banners as a cognisance, contemporary, in the history of heraldry, with coat-armour itself. As early as the 12th century, King Henry II. caused certain devices to be painted, which had a descriptive reference to his name; the *planta-genista*, or broom-sprig, and a jenet passing between two broom plants, the former of which is engraved upon the great seal of his son, Richard I., on either side of the throne. For many succeeding centuries these devices appear to have been confined to the royal use; but from the reign of Richard II., various houses of the nobility adopted their use. Thomas Mowbray, duke of Norfolk, appeared against Henry, duke of Hereford, in the celebrated joust at Coventry, upon a horse whose velvet trappings were embroidered with lions and mulberry trees, intended to typify his name. The devices of greatest notoriety were the white and red roses, by which the contending families of the royal stem are still metaphorically described. From the close of the 15th to the middle of the 16th century the friezes, entablatures, and stained windows of the more sumptuous habitations were crowded with devices. The Bourchier and Stafford knots were of this description. Camden, in his Remains, has a section entitled 'Rebus, or Name-Devices;' these were probably adopted in imitation of the emblems which, during the Neapolitan wars of the 15th century, were painted by the Italian chiefs upon their shields, accompanied by mottoes or quotations descriptive of enterprise, or of the general character of the bearer. Such were called Impresses, from the Italian word 'Impresa.'

DEVISE. [WILL.]

DEW is the moisture which, when the surface of the ground is colder than the atmosphere, whether at night or in the day, but principally, and as usually observed, between sunset and sunrise, is deposited from the air, in the form of minute globules, on the surface of bodies in contact with it. When the cold is extremely great, the vapour becomes solid instead of merely condensing into liquid water, forming a dendritic crystallisation of ice, or the globules of water freeze or solidify after deposition; producing what is called *hoar frost*, of two kinds.

The history of our knowledge of dew, as an object of scientific investigation, is singularly interesting, and the process by which it is formed involves several of the great principles of nature. In some remarkable speculations of Aristotle ('Meteor.' i. 10), it is supposed to be a species of rain formed in the lower atmosphere in consequence of the moisture which had been carried up during the day by evaporation being condensed by the cold of the night into minute drops. In 1784 Professor Patrick Wilson, of Glasgow, published a paper on hoar-frost in the Transactions of the Royal Society of Edinburgh, in which he supposes that cold is occasioned by its formation. In the course of the same year, and in 1788, Mr. Six communicated papers to the Royal Society of London in which he imagines that dew proceeds partly from the low temperature of the air through which the dew already formed in the atmosphere had descended, and partly from the evaporation of moisture from the ground, on which his thermometer had been placed. In a subsequent and posthumous work printed in 1794, the cold of the grass is, however, attributed, in agreement with the opinion of Mr. Wilson, altogether to the dew deposited upon it. Mr. Wilson and Mr. Six observed, that the production of (hoar-frost or) dew is accompanied with cold on the surface of the ground greater than in the atmosphere a few feet above, the differences being frequently 5, 10, or even more degrees of Fahrenheit's scale. This cold, as has just been mentioned, was considered as the effect of the formation of the dew, though this conclusion involved a very considerable difficulty; for as the transition of a body from the state of vapour to the fluid or solid form is always accompanied with an evolution of heat (which, as will appear in the sequel of this article, is really an element of the complex phenomenon under discussion), it might be expected that the surface on which the dew is deposited, and still more that on which the hoar frost is formed, would have its temperature raised, and no cause was apparent why it should be depressed.

Nearly contemporary with Six's last published observations, were some experiments made and described, though not explained, by M. Benedict Prevost, of Besançon. But Dr. Thomas Young, in his work entitled "Lectures on Natural Philosophy," published in 1807,—a mine of physical truth, which the labours of half a century have not exhausted,—completely accounted for the effects witnessed in those experiments, giving an explanation of them, of which it may be said, in accordance with a remark of his biographer the late Dr. Peacock, that it embraced the basis of the true theory of the cooling of the surface of the earth by radiation, and the interruption of that process by clouds, &c.—and by implication, that of the formation of dew itself. This, however, had remained unnoticed, and, indeed, until the discoveries of Leslie on radiant heat, but little further progress could be made in the investigation of this subject; and even the consequences of those discoveries remained for some time unperceived. But an obscure, because neglected, physician, giving his enforced leisure to physical inquiries, the late Dr. William Charles Wells, F.R.S., now discovered and established the true theory of dew, which Sir John F. W. Herschel ('Prel. Disc. on the Study of Nat. Phil.,' 168), has characterised "as one of the most beautiful specimens of inductive experimental inquiry," earnestly recommending the essay in which it is developed "for perusal to the student of natural philosophy, as a model with which he will do well to become familiar."

Dr. Wells, after verifying the facts previously observed, ascertained by numerous observations and experiments, that the cold at the surface, compared with that of the air above, precedes the formation of dew, and often exists without dew being formed; and that bodies become colder than the neighbouring air before they are dewed. The cold, therefore, which Mr. Wilson and Mr. Six supposed to be the effect of dew was found by Dr. Wells to be the cause of it.

The question, then, naturally arises, what are the causes which produce this low temperature of the earth, while the incumbent air is at a higher temperature? This is shown by the experiments and reasoning of Dr. Wells to be caused by the radiation of heat without an equivalent return. The surface of the ground allows a portion of the heat which it receives from the solar rays to escape by radiation when their action is withdrawn; hence its temperature falls; and if the air, holding watery vapour, rest upon it without much agitation (a circumstance by which, as the constant renewal of warm air imparts heat, the effect would be counteracted), a portion of the vapour will be condensed on the surface, and if the temperature is still lower, will be congealed: thus it is that dew and hoar-frost are formed only when the atmosphere is clear or the clouds not dense, for in the latter state they return an equivalent portion of radiant heat.

Dew forms in very different quantities on different substances under the same circumstances; thus, on metals it is sparingly deposited; on glass it forms abundantly, as it does also on straw, grass, cloth, paper, and other similar substances. Now as the metals radiate heat to a small amount only, and the other bodies mentioned in a much greater degree, they become consequently colder than the metals, and hence condense more vapour into dew.

Animal substances are among those which acquire dew in the greatest quantity; among these Dr. Wells found that swan's-down exhibited the greatest degree of cold in general, and was also most easily managed in experiment, as it was used while adhering to the skin of the bird. On other occasions wool was employed, and the following statements are the results of Dr. Wells's experiments with respect to the influence which several differences in the situation, mechanical state, and intrinsic nature of bodies have upon the production of dew.

A general fact is, that whatever diminishes the view of the sky, as seen from the exposed body, occasions the quantity of dew which is formed upon it to be less than would have occurred if the exposure to the sky had been complete; two parcels of wool, each weighing ten grains, were placed, one on the middle of a board, and the other to the middle of the underside; the two parcels were an inch asunder, and equally exposed to the action of the air: on weighing the two portions, it was always found that the upper portion had acquired most dew, the greatest difference being twenty grains to four grains.

The following is a tabular view of observations with respect to temperature made by Dr. Wells on the evening of the 19th of August, 1813:—

	6h. 45m.	7h.	7h. 20m.	7h. 40m.	8h. 45m.
Heat of air 4 feet above the grass	60¼°	60½°	59°	58°	54°
" wool on a raised board .	53½	54¼	51½	48½	44½
" swan's down on the same	54½	53	51	47½	42½
" surface of the raised board	58	57	55½	..	..
" grass plat . . .	53	51	49¼	49	42

Sir Robert Barker and Mr. Williams have both given accounts of the process by which ice is formed in Bengal, while the temperature of the air is above 32°; and its production was attributed, by the former altogether, and by the latter in great measure, to cold produced by evaporation. Dr. Wells's experiments, however, show not only that the evaporation which occurs is insufficient to account for the effect, but that the cold produced by radiation alone will satisfactorily explain it. On the subject of such cold, Dr. Wells makes the following curious statement:—"I had often," he says, "in the pride of half knowledge, smiled at the means frequently employed by gardeners to protect tender plants from cold, as it appeared to me impossible that a thin mat, or any such flimsy substance, could prevent them from attaining the temperature of the atmosphere, by which alone I thought them liable to be injured. But, when I had learned that bodies on the surface of the earth become, during a still and serene night, colder than the atmosphere by radiating their heat to the heavens, I perceived immediately a just reason for the practice which I had before deemed useless." And he follows up this part of the subject by relating some extremely simple experiments in proof of the efficacy of the practice, and in explanation of the effect by the processes of the radiation and reflexion of heat.

It had been remarked by Aristotle * and by other writers that dew appears only on calm and serene nights. This observation, according to Dr. Wells, is not to be received in its strictest sense, as he has frequently found a small quantity of dew on grass, both on windy nights, if the sky was clear or nearly so, and on cloudy nights, if there was no wind. If, indeed, the clouds were high, and the weather calm, he has sometimes seen on grass, though the sky was entirely hidden, no very inconsiderable quantity of dew. Again, stillness of the atmosphere is so far from being necessary for the formation of this fluid, that its quantity has seemed to Dr. Wells to be increased by a very gentle motion in the air: but he says, "I can aver, after much experience, that I never knew dew to be abundant, except in serene weather," and "dew has never been seen by me on nights both cloudy and windy." †

Dr. Wells remarks that, during nights which are equally clear and calm, dew often appears in very unequal quantities, even after due allowance has been made for any difference in their lengths: thus it is more abundant shortly after rain than during a long season of dry weather. It is generally more abundant during southerly and westerly winds than those which blow from the north and the east; but this remark, of course, only applies to particular localities. To the greater or less quantity of moisture in the atmosphere, at the time of the action of the immediate cause of dew, are likewise to be referred several other facts respecting its copiousness; these are thus stated by Dr. Wells ('Essay,' p. 10):—

"In the first place, dew is commonly more plentiful in spring and autumn than in summer; the reason is, that a greater difference is generally found between the temperatures of the day and the night in the former seasons of the year than in the latter. In spring this circumstance is prevented often from having a considerable effect by the opposite influence of northerly and easterly winds; but during still and serene nights in autumn dew is almost always highly abundant.

"In the second place, dew is always very copious on those clear and calm nights which are followed by misty or foggy mornings: the turbidness of the air in the morning showing that it must have contained during the preceding night a considerable quantity of moisture.

"Thirdly, I have observed dew to be unusually plentiful on a clear morning which had succeeded a cloudy night. For the air having, in the course of the night, lost little or no moisture, was in the morning more charged with watery vapour than it would have been if the night had also been clear.

"Fourthly, heat of the atmosphere, if other circumstances are favourable, which, according to my experience, they seldom are in this country, occasions a great formation of dew. For, as the power of the air to retain watery vapour in a pellucid state increases considerably faster, while its temperature is rising, than in proportion to the heat acquired, a decrease of its heat, in any small given quantity, during the night, must bring it, if the temperature be high, much nearer to the point of repletion before it be acted upon by the immediate cause of dew, than if the temperature were low. * * * * *

"In the last place, I always found, when the clearness and stillness of the atmosphere were the same, that more dew was formed between midnight and sunrise than between sunset and midnight, though the positive quantity of moisture in the air must have been less in the former than in the latter time, in consequence of a previous precipitation of part of it. The reason, no doubt, is the cold of the atmosphere being greater in the latter than in the prior part of the night."

The experiments of Dr. Wells were repeated in France by M. Pouillet; but two sets of experiments of some value, undertaken for special purposes by the late Professor J. F. Daniell, appear to have been the only attempts made in England to confirm and extend the results at which Dr. Wells had arrived, until after the establishment of the magnetical and meteorological department of the Royal Observatory at Greenwich, when Mr. James Glaisher, F.R.S., the superintendent (as an assistant of the astronomer royal) of that department, instituted, carried on for some years, and afterwards communicated to the Royal Society, an elaborate and most valuable series of observations and experiments "On the amount of the Radiation of Heat, at night, from the earth, and from various bodies placed on or near the surface of the earth." These were published in the 'Philosophical Transactions' for 1847, of which they occupy 113 pages, including 108 tables of observations. The subject of the production of dew was, of course, only a part of Mr. Glaisher's researches; but the most general result he obtained on that subject, was entirely conformable with that enunciated by Dr. Wells, and is stated in the following terms:—

---

* Meteor. lib. i, c. x. et De Mundo, c. iii.

† 'An Essay on Dew, and on several appearances connected with it,' Lond. 1814, p. 65. It may be well to record, as the late Dr. T. Thomson pointed out at the time, that the word *conduction*, as applied to a certain process of the propagation of heat (and subsequently to that of electricity) was first introduced into the English language by Dr. Wells in this work. A second edition of the Essay appeared in 1815, which was republished shortly after the author's death, in a now scarce volume, containing other writings by him, including his autobiography, Lond. and Edin. 1818, 8vo, reissued in 1820.

"The formation of dew was found to depend solely on the temperature of the bodies upon which it was deposited, and it never appeared upon them till their temperatures had descended below that of the dew-point in their locality, as found by observations of a dry and wet bulb thermometer placed in their vicinity. The amount of water thus deposited was the greatest upon the substances whose temperatures were the lowest." The *dew-point*, as will be explained in the next article, is the critical temperature below which the vapour of the atmosphere begins to be condensed into moisture, the "point of repletion" of Dr. Wells, as above.

At the commencement of his experiments Mr. Glaisher made some precise and important observations, on the difference between the temperature of a thermometer and that of a body in contact with it, which must here be noticed, on account of the bearing which they have on the conduct of experimental inquiries of this nature. Among the bodies found to radiate heat freely (in agreement with previous knowledge), was glass, which thus very readily became wet with dew. In consequence of this property, the tube of a naked thermometer, which was lying on a substance entirely free from moisture, was frequently found covered with dew, and therefore it seemed probable that the temperature exhibited by the instrument was not that of the body in question. On such instances occurring an attempt was made by Mr. Glaisher to correct the error, by enclosing the thermometer stem in a tube made of gilt paper; the bulb alone, resting on the substance, remained exposed to the sky. The differences between the readings of a thermometer thus enclosed, and when naked, were found to be sensible, but small in amount; it was also observed, that when the thermometer was wholly naked the stem was at times wet when the bulb itself was dry; and at all times much less moisture appeared on the bulb than on the stem, unless the disposition of the substance in question to become cold was the same with, or greater than, that of the glass. The error arising from this cause was chiefly confined to the consequent contraction of the mercury in the stem, and not in the bulb, and which was considered to be avoided by the use of gilt paper. The error in all cases must have been small. Mr. Glaisher found, in addition, that one of the many sources from which the reading of a thermometer placed on the ground is affected, is the heat evolved during the change of the watery vapour in the atmosphere into dew, the amount of which appeared to be about 4° Fahr. from all the experiments he made. The difficulty this fact occasioned to some of the earlier theorists on dew has been noticed above.

It was found, in the course of these experiments, that the differences between the temperature of the air and of bodies on the earth, at night, in equally calm and clear weather, were the same at every period of the year, but it was also found that the amount of dew deposited during such times was much greater in summer than in winter. This is easily accounted for, from the well-known relation existing between temperature and moisture. At all seasons of the year, at night, the depression of the temperature of the dew-point below that of the air is small, or the air is in a state of saturation nearly, and therefore in summer a certain diminution of temperature would cause much more vapour to be changed into water, than an equal diminution in winter would do; in agreement with the previous reasoning of Dr. Wells.

With respect to the occasional formation of dew in the day-time, Mr. Glaisher remarks, "Radiation of heat from the earth to the heavens must exist at all times, both day and night, and in all states of the sky. Generally, when the sun is above the horizon, the heat emitted by it to the earth will overbalance that which the earth radiates upwards; at times, however, in places shaded from its direct beams, the amount of heat radiated exceeds that received from the sun and all other sources, and dew will be continually deposited throughout the day." Some instances of this are exhibited in his Tables. Dr. Joseph D. Hooker, we may add (in his 'Himalayan Journals,' vol. i., p. 196), has recorded, in conformity with this principle, that in East Nepaul, the sun, in many places, does not reach the bottom of the valleys until 10 A.M., and is off again by 3 P.M.; and that the radiation to a clear sky is so powerful that dew frequently forms in the shade throughout the day. But in these regions the clearness of the sky is such, that at night Dr. Hooker found the upper blanket of his bed to become coated with moisture, from the rapid abstraction of heat by the tarpaulin of his tent, itself frozen by its own radiation.

From some of Mr. Glaisher's tables, containing the results of observations when the excess of air-temperature above that of long grass amounted to 5°, 6°, 7°, or 8°, it appears that at such times the sky was frequently cloudy, and when wholly so, that the clouds were high; that the air was in frequent motion, and at times the wind was blowing with a pressure of 4 lbs. on the square foot; that the atmosphere was occasionally thick by haze or vapour, and that under these circumstances, dew was seldom deposited. Other tables contain the results of the observations when the excess was 9°, 11°, or 12°, and at those times the sky was generally clear, the air calm, and the atmosphere frequently hazy or misty, or vapour or fog was prevalent, and dew was also frequently deposited; in two cases, one in February and the other in November, the sky was wholly covered by high and thin clouds, the radiation of heat from which was thus inadequate to counteract that of the earth, as had been before observed by Dr. Wells.

It was also observed by Mr. Glaisher, that the various amounts of dew deposited, at the same time, on different bodies at night, were, as near as could be determined, proportional to the amount of the depression of their temperature below that of the dew-point. "Hence, it is evident," he concludes, "that all hygrometers formed of any of these substances [a variety of bodies in common use, chiefly belonging to the mineral kingdom, as chalk and graphite, but including the common metals also], or of any animal or vegetable substance, when exposed to the clear sky at night, will be cooled by the radiation of their heat, and will cool the air in contact with them; and thus indicate a greater degree of humidity than actually exists (as had been pointed out by Dr. Wells, with respect to the organic substances); and particularly so, should their temperature descend below that of the dew-point, and dew be actually deposited upon them."

Contemporary, as it would appear, with the researches of Mr. Glaisher, and equally elaborate and satisfactory, were those of the lamented Italian philosopher Melloni, who had made almost the entire subject of radiant heat emphatically his own. They were read to the Royal Academy of Sciences of Naples, very shortly after Mr. Glaisher's paper was read before the Royal Society of London; seem to have been undertaken, in part, on account of the obstinate and perhaps traditionary retention in certain Italian schools of science of the ancient notions on the formation of dew; and are throughout, in the most remarkable manner, confirmatory of the discovery of Dr. Wells, while they correct some of the tacit admissions of his theory and elucidate others. They are also, in a great degree, comparable in detail with those of Mr. Glaisher, with which they present an accordance, that when characterising the labours of two physicists accurately versed in their subject, is itself strong evidence of the truth. But M. Melloni adds to the causes of complication in the actual phenomena of dew, as investigated by the English meteorologist and his predecessors, that of the great emissive or radiant power of water, which has important bearings on every part of the series of phenomena, after the first actual deposition of dew, and in all probability is the reason why the thermometer wetted with dew, described by Mr. Glaisher as above, did not introduce any serious error into his observations.

A great part of Melloni's three memoirs is devoted to the experimental verification of the proposition that almost all the facts which precede and accompany the formation of dew result from the presence, of shorter or longer duration, of the air around the radiating surfaces. He investigates with great success the circulation of temperature, and of local amount of vapour in the different atmospheric strata adjacent to the earth's surface, under the influence of nocturnal radiation. For the results, however, as well as for a discussion of the geographical distribution of the varying phenomena of dew, we must refer to the author's original memoirs 'On the nocturnal cooling of bodies exposed to a free atmosphere in calm and serene weather, and on the resulting phenomena near the Earth's surface,' 'Ann. de Chim. et de Phys.,' Feb. and April, 1848; or (Taylor's) 'Scientific Memoirs,' vol. v., pp. 453-476, 530-552. [CLOUD, HOAR-FROST, HYGROMETRY, METEOROLOGY, RADIATION OF HEAT, RAIN, VAPOUR.]

DEW-POINT. The critical temperature, usually expressed in thermometrical degrees, of the double atmosphere of air and aqueous vapour (or of any portion of the earth's atmosphere in its natural state), below which the latter becomes condensed into liquid water, and above which that atmosphere will convert into vapour and absorb into itself (augmenting the quantity of the vapour) water with which it may be in contact. In the former case the water becomes condensed into minute globules like those of the clouds, which, if the condensation take place against solid surfaces of lower temperature, become attached to those surfaces in the form of dew; hence the origin of the term.

Viewing the same subject in a slightly different aspect, Sir John Herschel defines the dew-point as "the temperature which the air ought to have, so as to be exactly saturated with the quantity of vapour it actually contains."

The phrase *depression of the dew-point* denotes the quantity of heat to be abstracted, or the number of degrees of the thermometer below the actual temperature of the atmosphere which it requires to be cooled, in order that the vapour it contains may become so condensed.

The following examples will illustrate the use of these expressions. In the Greenwich Meteorological Observations for 1857 it is recorded that, on July 15, the mean daily reading of the thermometer, or the air-temperature, was 72°·7 Fahr., and that of the dew-point 58°·2, the difference of which, 14°·2, is the depression of the dew-point; and that on December 15, the air-temperature was 46°·9, and that of the dew-point 44°·8, the depression consequently, 2°·1.

The mean air-temperature for the same year was 51°·0, and that of the dew-point 45°·8; the depression 5°·2, which is slightly below the average of the climate.

In the Sikkim Himalaya, according to Dr. J. D. Hooker, the dew-point, on the average of the year, is 49°·3, or 3° below the mean temperature of the air. In the dampest month (July) the mean dew-point is only eight-tenths of a degree below the mean air-temperature, whilst in December it sinks 10° below it.

Professor C. Piazzi Smyth found that no dew was formed on the Peak of Teneriffe, at his astronomical observing stations. "In a region," he says, "where the average depression of the dew-point was, as we found it, the unheard-of quantity of 40°, and where it was not unfrequently above 50°, the formation of dew was physically impossible." ('Phil. Trans.' 1858, p. 478.)

The determination of the dew-point and of its depression being as it were the *index* of all hygrometry, a variety of methods and processes have been devised, and instruments constructed for the purpose, or virtually so, from the era of the Academicians del Cimento to that of Dalton, and from his time to the present. This long and varied experience has resulted in the almost universal adoption of a method at once simple and satisfactory—the simultaneous observation of the dry-bulb and the wet-bulb thermometers, an explanation of which will be given in the article HYGROMETRY. The use of Daniell's hygrometer, however, for this purpose, is continued by some meteorologists.

The *Vapour-Plane* in the atmosphere, on which the clouds float, is the superior limit of a stratum which is at the temperature of the dew-point, at and below which cloud is continually forming, while it is as continually being resolved into invisible vapour above. [CLOUD, METEOROLOGY, VAPOUR, VAPOUR-PLANE.]

DEXTRINE ($C_{12}H_{10}O_{10}$). An isomeric modification of starch procured by boiling common starch in dilute sulphuric acid, and also in some other acids; by this treatment the starch soon loses its consistence and becomes thin and limpid, being converted into *dextrine*, so called from its action on polarised light, in causing the plane of polarisation to deviate to the right. When sulphuric acid is used, it is to be saturated by the addition of chalk, and the liquor, filtered from the sulphate of lime formed, is to be evaporated to dryness in a water-bath.

Dextrine thus obtained is a white gum-like mass, without any appearance of crystallisation, soluble in cold water, and precipitable from it by alcohol. Iodine is stated by some authors sometimes to produce no change in the solution of dextrine, and on other occasions to give a purplish red tint. The non-production of colour has, however, been stated to be a test of the perfect conversion of the starch.

Dextrine may also be prepared by the action of an infusion of malt kept some time at 150°. Its composition is similar to that of starch.

When the heat is continued after the formation of the dextrine, this substance is converted into grape sugar, and this effect is produced with great readiness.

Dextrine, but not quite pure, is used by calico-printers as a substitute for gum; it is obtained by merely subjecting starch to the action of heat, and thus prepared is known by the name of British gum. [BRITISH GUM.]

DEXTRO-RACEMIC ACID. [TARTARIC ACID.]

DEY. The origin of the word dey is uncertain. Some have derived it from the Turkish *dâï*, "a maternal uncle," and have supposed that this designation was given to the chiefs of the states of Barbary to express their almost paternal authority in the Ottoman empire, and the high esteem in which they were held by the Porte. The name is at all events of more ancient date than the Ottoman dominion in northern Africa, since we find it used as early as the end of the 11th century as the title of the emissaries of the Assassins or Ismaelites. The dignity of dey, or bey, of Tunis, Tripoli, and Algiers, was borne by the governors who were tributaries to the Turkish empire. Algiers is now in the possession of the French, Tripoli is a pashalic of the Turkish empire, and in Tunis alone does the title exist, though it more frequently appears as pasha-bey. [ALGERIE, L'; TRIPOLI; TUNIS; in GEOG. DIV.]

DIABE'TES, the discharge of a preternatural quantity of urine, the chemical composition of which is also essentially changed. In this disease the urine is not only unusually large in quantity, but it is either altogether destitute of several of its constituent principles, or it contains them only in very minute proportions, while it acquires a new ingredient, a quantity of sugar, which imparts to it a sweet taste. Medical writers are not agreed whether the impregnation of the urine with a sufficient quantity of saccharine matter to render it sweet to the taste be absolutely essential to the disease; it is therefore usually divided into two species, namely, *diabetes insipidus*, when there is discharged a preternatural quantity of urine which is perfectly insipid, and *diabetes mellitus*, when the unusual quantity of urine which is voided is sweet to the taste.

The discharge of a larger quantity of urine than natural, unaltered in its chemical constitution, may arise from numerous causes of a temporary nature, scarcely deserving the name of a disease, and certainly not forming a disease of a specific character. The term diabetes should therefore be restricted to that specific disease in which the secretion of urine is preternaturally increased, and its chemical composition at the same time essentially changed.

In diabetes, properly so called, the urine is generally so clear that it appears at first sight to be entirely without colour; but viewed in a certain light, it is seen to be slightly tinged with a yellowish green, or it is of a pale straw colour. Examined by the taste, it is almost invariably found to be more or less sweet; and when chemically analysed, it is ascertained to contain, usually in considerable quantity, a saccharine matter, which has many of the properties of common sugar. Its odour is likewise peculiar; it is commonly compared to the faint odour of violets, or to that of sweet whey or milk. Its specific gravity commonly varies from 1·025 to 1·052. From a table given by Dr. Henry, it appears that ten pounds of diabetic urine, at the average specific gravity of 1·040, yields upwards of a pound and a quarter of solid extract.

The quantity of urine voided in this disease is sometimes enormous. In one case on record, it amounted to the prodigious quantity of 52 pounds in the 24 hours; but instances are by no means uncommon in which the quantity amounts to from 25 to 35 pounds every 24 hours for weeks or even months together. Although one of the most constant constitutional symptoms attendant on this disease is inordinate thirst, yet the urine daily voided almost always exceeds the quantity of liquids drank, and sometimes the whole of both solids and liquids.

The diabetes commonly comes on slowly and almost imperceptibly, at least without any such disorder of the general health as to attract particular notice. It therefore sometimes exists a considerable time before it becomes known; and the change in the quality of the urine is at length discovered by accident; for its quantity may not at first be very much increased, or if increased to such a degree as to attract notice, the circumstance is usually attributed to some temporary cause. At length, however, the constitution manifestly suffers; the strength and vigour fail, the patient feels languid and indisposed to make any physical exertion, the mouth is dry, the tongue clammy; there is unusual thirst; a slight degree of fever is set up, indicated by alternate chills and heats; but the most remarkable circumstance is a change in the condition of the skin, which becomes dry, harsh, and sometimes even furfuraceous, or apt to peel off in scales. The thirst now increases to such a degree as to be evidently morbid; this is often, though not always, accompanied with voracious appetite; and the quantity of urine discharged not only decidedly but steadily increases. If the observation of these circumstances should lead to the examination of the urine, it is found to be sweet to the taste and of a light green or pale yellow colour. The patient meantime is commonly observed to have lost flesh, and is troubled with a sense of heat and pain in the region of the stomach, with aching in the back and loins, and uneasy sensations in the course of the urinary passages. The bowels are usually costive, the breathing short and oppressed, with a dry tickling cough, and the pulse is commonly frequent. As the disease advances, all these symptoms increase in intensity; the tongue becomes either loaded with a dark-coloured fur, or unnaturally clean and of a dark or purplish red colour; the thirst is more urgent; the appetite, formerly voracious, is now perhaps abolished or depraved; the bowels are more constipated; the skin more harsh and scaly; while the urine, increasing in quantity, becomes still more altered in quality. At length there come on headache, giddiness, occasional loss of vision, impaired memory, and diminished mental energy. The debility and emaciation steadily increasing, the patient sinks with many of the symptoms of hectic fever, or is suddenly cut off by consumption, dropsy, apoplexy, or some other incurable disease established in some vital organ.

From the preceding account it appears that this disease is generally of a chronic character; but it sometimes attacks in an acute form, the marked symptoms of the malady coming on suddenly in a previous state of apparent health, and proving fatal in a few days. This, however, is very rare. It seldom runs its course under some months, and it sometimes lasts several years. It frequently disappears for a while, especially under proper treatment, and then recurs after the lapse of a few months or years; so that the relief obtained is commonly only temporary, the disease resuming all its severity from a slight exposure to its exciting causes, or from any considerable deviation from the proper diet and regimen. Hence it is perhaps the prevalent opinion among physicians that it is absolutely incurable. There cannot be a question that by appropriate remedies and great and persevering care on the part of the patient, it is capable of being very much relieved, and even of being altogether suspended for an indefinite number of years. The evidence of this is indubitable; but it is more doubtful whether it can be permanently and radically cured.

An inspection of the organs after death does not throw so much light on the seat and nature of diabetes as might have been expected. In several cases in which the symptoms were present in a very intense degree during life, no appearance of change of structure in the urinary organs could be detected after death. In general, however, the kidneys are larger than natural; more turgid with blood; more flaccid; softer, and more easily torn. Sometimes, though rarely, they are found in the contrary condition, smaller and harder than natural, and their membranous envelope and their cortical substance, are of a cartilaginous firmness and density. Several observers have recorded the remarkable fact, that the organic nerves which supply the kidneys are greatly enlarged in size. The ureters are commonly dilated, and the urinary bladder is often thickened. It is obvious that these morbid states of the kidneys may be the effects of the disease, and not the causes of it. Next to the kidneys, the organs most commonly found in a state of disease are the mesenteric glands, which are enlarged and hardened. The absorbent glands in general are occasionally enlarged, softened, and more vascular than natural; the thoracic duct is sometimes dilated, and the lungs are constantly found studded with tubercles in all their stages of disease. Though the functions of the stomach, intestines, and liver are so often disordered during life, yet it is comparatively rare that any kind or degree of organic change is discoverable in these organs after death.

The true and invariable antecedents of diabetes, or its proper exciting causes, are still involved in obscurity. It has been observed to come on after exposure to several morbid agents, as the long-continued application of cold and moisture, especially after the body had been previously over-heated, implying a sudden check to the perspiration, and a corresponding determination of blood from the skin to the internal organs; exhaustion arising from excessive evacuations, or excessive fatigue, bodily or mental; in short, whatever greatly and suddenly depresses the powers of life: but such causes are applied in all their intensity to the human body many thousands of times for one in which they produce a case of diabetes.

Although morbid anatomy throws so little light on the nature of this disease, the recent discovery of sugar in the blood affords grounds for supposing that the real seat of this disease is in the blood, or the organs concerned in the production of the constituents of the blood, rather than in the kidneys. Sugar is not, however, found in all blood, but was first found in the hepatic vein, and was found to be absent in the portal vein. This discovery was followed by researches on the function of the liver, more particularly by M. Bernhard, of Paris, who was the first to announce the fact that the liver had the power of converting the constituents of the blood in the portal vein into sugar. The sugar found in the liver more closely resembles in its properties, glucose or grape-sugar, than cane-sugar. It is this sugar apparently that increases in the blood during the disease called diabetes, and this is confirmed by the fact that there is a close resemblance between diabetic- and liver-sugar.

As in the diagnosis of diabetes it becomes a matter of importance to detect the presence of sugar in the urine in the earliest stages, much importance has been attached to the means of discovering small quantities of sugar in the urine. The tests used are numerous, but it may be sufficient to mention here those which are most conveniently applied.

The first we may mention is a colour test, and is known as Moore's test. It consists of adding the *liquor potassæ* to the suspected urine in a test-glass and then exposing to the heat of a spirit-lamp; if sugar is present, the urine becomes changed into a bright claret colour. Of course the intensity of the colour will depend on the quantity of the sugar. Dr. Garrod has proposed a modification of this test in his glucometer, which by supplying a standard solution enables the experimenter to judge of the quantity of sugar present by the quantity of liquor potassæ required to produce the standard colour.

Another test more frequently used is that of Trommer. This depends on the facility with which diabetic sugar is decomposed in contact with an oxide of copper. A solution of sulphate of copper is added in a test-tube to the urine, sufficient to colour it blue. Liquor potassæ is then added, which throws down a hydrated oxide of copper. On exposure to heat the sugar is decomposed, and the oxide of copper is reduced to the state of a suboxide, which is known by its red colour. This test is equally efficient for grape-sugar and liver-sugar, but the above changes go on very slowly in cane-sugar.

Crystals of sugar may be detected in the urine after evaporation, under the microscope, and the process of fermentation may be established by the addition of yeast. These are other tests, but not so much to be depended on as the preceding.

Various theories have been proposed to account for the sugar in the urine, and a treatment has been recommended in accordance with such theories. Dr. Prout attributed the disease to a deranged state of the digestive organs, in which he believed the food was converted into sugar in the stomach and intestines, and thence carried into the blood.

Dr. Bence Jones has explained the occurrence of the sugar, on the ground that in health the natural changes of certain portions of the food are from starch to dextrine, from dextrine to sugar, and from sugar to carbonic acid. But in diabetes the last stage of change is arrested, and the sugar not being converted into carbonic acid is carried off from the blood by the kidneys.

M. Bernhard, as the result of his researches on the sugar-forming properties of the liver, regards diabetes either as the result of a too active performance of the function of sugar-forming in the liver, or as produced by a deficient decomposition of the sugar naturally thrown into the blood.

The treatment suggested by these theories is not inconsistent with the mode of treatment employed by the older practitioners of medicine. It was early suggested that those kinds of food which contained substances that were easily converted into sugar, and sugar itself should be withheld, and many patients were found to improve greatly, and even to get well, by withholding substances containing starch and sugar from their diet. In some cases this plan has been pushed to the extent of giving the patient nothing but animal food. This, however, is so repugnant to the natural taste of the patient that most practitioners have allowed a limited quantity of bread, or prescribed a kind of bread in which the gluten is in much larger quantities than usual. Such bread has been manufactured for the use of diabetic patients. It cannot be said, however, that such bread is necessary to the cure of diabetic patients, as many have improved on a diet in which animal matter has constituted a principal part of the diet, combining this with a small proportion of the farinaceous vegetables.

The most curious point in the history of this disease is, that cases have been recently published by Dr. Budd, of Bristol, and others, in which they have administered large quantities of sugar to diabetic patients with decided advantage to the patient. Although there can be no doubt of the improvement thus recorded, abundance of cases exist which show that the free administration of amylaceous and saccharine foods has been attended with an increase of the diabetic symptoms, and that relapses have been frequent after improvement on an animal diet, by the partaking of fruits and farinaceous foods.

These facts lead to the conclusion that diet alone will not cure diabetes. Nor are there any special remedies that will effect a cure. But the treatment should be directed to the restoration of that state of the system in which only the normal quantity of sugar is allowed to remain in the blood. Under these circumstances the digestive system, the liver, and the blood, should, if possible, be restored to their natural condition. This may be done by the administration of purgatives where needed, by giving tonics such as iron and quinine, which restore the tone of the system, and especially in the administration of medicines which act on the nervous system. There is reason to believe that deranged conditions of the nervous system alone will cause the appearance of sugar in the urine quite short of ordinary diabetic symptoms, and there is abundant evidence to show that opium, camphor, kreasote, and remedies of this class will frequently control the quantity of sugar in the urine.

An important element in the treatment of these cases is abundant exposure to fresh air. Horse exercise, or walking where it can be borne, should be recommended. This should be done on the principle of securing the greatest possible amount of oxidation for the constituents of the blood, as there can be no doubt that one element of the disease consists in deficient change in the blood.

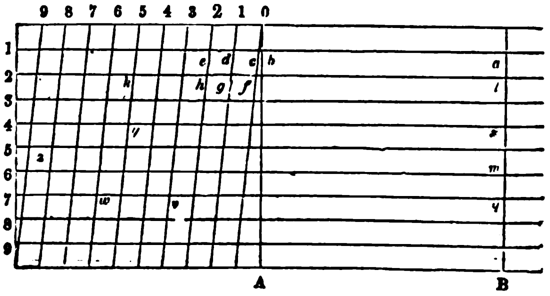
The state of the skin also demands attention. Warm bathing and the vapour-bath have proved beneficial, and daily ablution of the whole body in warm and cold water, according to circumstances, should be prescribed. Warm flannel clothing should also be worn next the skin.

DIABETIC SUGAR. [Grape Sugar.]

DIACAUSTIC CURVE. [Caustics.]

DIAGONAL, a line drawn from corner to corner; any line drawn from point to point of a figure, which is not part of its boundary, provided the two extreme points be in the intersection of boundary lines. A figure of n sides has $\frac{1}{2}n(n-3)$ diagonals.

DIAGONAL SCALE. Equidistant parallel lines cut *all* lines drawn across them into equal parts. Consequently, a set of equidistant parallels laid down upon a ruler, with oblique lines of various lengths drawn across them, give, with the compasses, the means of immediately taking off various proportions of those lines. But the common diagonal scale is as follows, and facilitates the laying down of the hundredths of units in a scale of equal parts. A description of its use will immediately suggest the principle of it to any one slightly acquainted with geometry. A B is the unit of the scale (usually a quarter of an inch): the diagonal scale professes to determine the hundredth part of this, or the four-hundredth of an inch, and may perhaps, with care, be depended on within the two-hundredth of an inch. By taking off various lines, and writing their numerical designations opposite, we may show the use and meaning of the construction.



$ab=1{\cdot}00$ $ae=1{\cdot}21$ $lh=1{\cdot}22$ $mz=1{\cdot}96$

$ac=1{\cdot}01$ $lf=1{\cdot}02$ $lk=1{\cdot}52$ $qv=1{\cdot}37$

$ad=1{\cdot}11$ $lg=1{\cdot}12$ $xy=1{\cdot}54$ $qw—1{\cdot}67$

DIAGRAM, a mathematical figure of any kind.

DIAL, an instrument for determining the hour of the day from the shadow of a point or line upon a graduated surface. The shadow may be that formed by the light of the sun or moon, and be either direct or reflected. The dial, when the sun is used, is called a sun-dial; and when the moon, a moon-dial. The latter kind, as well as those in which the light is reflected, are mere objects of scientific curiosity, and no further notice will be given of them in this work; but the history and structure of the sun-dial will be found under SUN-DIAL.

DIALECT (*διάλεκτος, δια-λέγ-εσθαι, to converse*), an appellation given to a language when spoken of in contradistinction to some other language which it resembles in its general features, though differing from it more or less in the details. Almost all the languages which we are acquainted with may be arranged in distinct classes or families, and the relationship subsisting between the members is, generally speaking, pretty obvious. Sometimes the parent language from which they are all descended is still extant, and in that case it is frequently easy to trace the variations in orthography, inflexion, and conjugation from the parent stock, and to determine the principles which governed these changes. These inquiries, whenever they can be successfully prosecuted, are of the greatest importance, as well to the critical historian as to the philologer; for the language of a people points at once to their mental characteristics and the external changes to which they have from time to time been exposed. Thus the Dorian dialect of the Greek language, in the broadness and harshness of its vowel sounds, corresponds to the grave and austere character of the Dorian people; and whenever a warlike race has taken up its abode among a peaceful agricultural population, traces of this mixture of population are always found in the language, in which the military and political terms are mostly peculiar to the language of the conquerors, while for the words referring to farming and domestic economy, the aboriginal language is retained. This is strikingly the case in the Latin and English languages. The two most widely diffused families of languages known to us are the Indian-Gothic and the Semitic; the former includes the Sanscrit, Zend, Armenian, Greek, Latin, Lithuanian, Sclavonian, Teutonic, and Celtic dialects, in which the resemblances, though sometimes rather distant, are still more or less perceptible. The Semitic family contains the Hebrew, Syriac, and Arabic tongues, with others less known to modern Orientalists. Many of these primary dialects are divided into several sub-dialects: for instance, the ancient Greek had at least three distinct dialects, the Æolian, Dorian, and Ionian.

The differences in the modes of speaking in England can hardly be called dialectical, in the sense in which the word dialect has been explained: such differences, generally speaking, are nothing more than peculiar words or phrases which the written language has not adopted, but which are not the less on that account genuine members of that Teutonic family of which the written language itself is only a part.

But so far as any of these varieties have been committed to writing, and are admitted by a large portion of the population to be a faithful representation of the language in daily use among them, so far such varieties may not inaptly be called dialects. Such are many of the poems of Burns, and parts of the novels of Scott. In ordinary conversation in England, the words "provincialism" and "dialect" are often used as synonymous, and as expressing some usage of language which is at variance with the established language of the educated and that of the best writers. It is, however, only a vulgar mistake to consider such words as "corruptions" of language, which they very rarely are. As a general rule, such words and phrases, and such peculiar pronunciations as characterise nearly every county of England, are of the genuine Teutonic stock; and that language which is now the established language of literature, and which has rejected some of the so-called provincialisms and adopted others, might, under different political circumstances, have contained these elements in a different proportion. If the metropolis of England had been on the Severn, the Humber, or the Tyne, who can say how much the written language might have been affected by this circumstance?

DIALECTICS (*διαλεκτικὴ τέχνη*), the old name for the practical part of logic. The word properly signifies "the art of conversation," and its use as a name for the art of reasoning seems to have arisen from the fact, that Zeno the Eleatic, who was the first compiler of a system of logic, was also the first writer of dialogues. It is also to be remembered, that formal argumentation among the Greeks was generally carried on by means of question and answer, and Aristophanes uses the more common word *dialexis* (*διάλεξις*), to signify the logic of the Sophists. There were several systems of logic between Zeno and Plato, as, for instance, those of Protagoras, Polus, Gorgias, Euclid, and Eubulides. Socrates never committed any thing to writing; but if we take the representations given of his mode of reasoning by Plato and Xenophon, so far as they agree, we must look upon him as in some measure the originator of Plato's scientific method of arguing. (See Schleiermacher on the Worth of Socrates as a Philosopher, in the Transact. of the Berlin Acad. for 1815, transl. in the Philolog. Mus. vol. ii) Plato considered dialectics as the science of definitions ('Sophist.' 253), and as every definition must include both genus and difference, he found it necessary to invent a theory of abstract ideas as the basis of his dialectics; for the ideas (*ἰδέαι*) and the genera (*εἴδη*) were, he considered, related merely as subject and object; and he thought that, without assuming the objective existence of the genera, he could have no real general ideas, and so his definition, and consequently his whole dialectical system, which he believed to be the only available means of finding out the truth, would fall to the ground. (Van Heusde, 'Initia Philosoph. Platon.;' Cousin, 'Fragmens.') Aristotle's dialectics were based upon a scale of categories or predications, much the same with those of Archytas; he did not think it necessary to assume any *à priori* abstract notions, but conceived it was sufficient for all logical purposes to generalise after experience. (Facciolati's 'Logica Peripatetica.') The dialectics of the Stoics appear to have been little more than a system of grammatical rules. For the application of dialectics the reader is referred to the article LOGIC; and to the works on the subject by Sir W. Hamilton, A. De Morgan, W. Spalding, and others.

DIALLYLUREA. [UREA.]

DIALURAMIDE. [URIC ACID.]

DIALURIC ACID. [URIC ACID.]

DIAMAGNETISM. There are certain bodies which are attracted indifferently by either magnetic pole, and are termed *magnetic;* but there are others which, when brought near to the magnetic pole, are repelled instead of being attracted; such bodies are called *diamagnetics*, and the branch of science which treats of them is termed *Diamagnetism.* [MAGNETISM.]

DIAMETER, a word most commonly applied to the line drawn through the centre of a circle, and bounded on both sides by the circumference. But the most general meaning is as follows:—Whenever any point is called a centre, any line drawn through the centre is called a diameter. And any point which bisects all lines drawn through it from opposite boundaries is called a centre. Thus the circle, the conic sections, the parallelogram, the sphere, cube, and parallelopiped, all have *centres*, and by analogy, *diameters.*

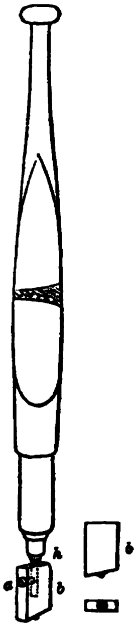
DIAMIDES. [AMIDES.]

DIAMIDO-BENZOIC ACID ($C_{14}H_3(H_2N)_2O_3,HO$). A derivative by reduction from *binitrobenzoic acid.* [BENZOIC ACID.]

DIAMINES. [ORGANIC BASES.]

DIAMOND. The pencil diamond used by glaziers in cutting glass is a small fractured piece of the gem. The part of the diamond used for cutting is of a trapezoidal shape, weighing about the 60th part of a carat, and is set in a wooden handle, which consists of a rounded piece of rose-wood flattened at the two sides to fit between the sides of the fore and middle fingers.

Two kinds of pencil diamonds are in use. The old diamond is merely set fast in a conical shoulder. A difficulty is always experienced in cutting glass with this sort of pencil, owing to the uncertainty of placing the gem at once at the proper angle with the glass, so as to make it cut and not scratch; this difference depends upon the axis and edges of the crystal. The patent diamond, of later invention, overcomes this difficulty. The form is represented in the annexed figure. The peculiarity consists in the diamond being set in a parallelopiped shoulder, *b*, *b*, the right angle of the lower end of which is cut off and forms the correct angle at which the diamond when set will cut the glass. The upper end of the shoulder swivels at *h*, but is stopped from going too far by the screw *a*. The object of this is to prevent the necessity of shifting the handle in the hand when placed against the ruler laid on the glass. The lower end of the shoulder, showing the diamond, is represented at *c*. A large diamond is not so fit for the purpose of cutting glass as a small one. The diamond is usually about the size of an ordinary pin's head, and is set in a nipple of brass or copper. It is an error to suppose that diamonds will not wear out. In the shops of wholesale glaziers, where the diamond is in constant requisition, one of these instruments is worn down in a month or six weeks, so as to require resetting, after which, with the same wear, it usually lasts another month, and then becomes useless. It may be presumed that they travel over some miles of glass before they are worn out. In cutting the glass, care is taken not to press too heavily on the diamond, which is apt to scratch instead of cutting the glass; such heavy pressure also spoils the diamond.



The cutting of glass may also be effected by unusually hard specimens of certain other minerals; but the diamond is the only means regularly employed.

DIAMOND. [CARBON.]

DIAMYLAMINE. [AMYL.]

DIAMYLANILINE $\left(N\begin{cases}C_{12}H_5\\C_{10}H_{11}\\C_{10}H_{11}\end{cases}\right)$. An organic base derived from *aniline* by the substitution of two equivalents of amyl ($C_{10}H_{11}$) for two of hydrogen.

DIAMYL-OXAMIDE. [OXAMIDE.]

DIANA. [ARTEMIS.]

DIANILIDES. [ANILIDES.]

DIAPA'SON, in Music (*διὰ, through,* and *πασῶν, of all*), the interval of the octave, so called because it includes all admitted musical sounds. It likwise signifies the compass of any voice or instrument; and the French employ it to express what in England is meant by the term *concert-pitch.* [CONCERT-PITCH; TUNING.]

DIAPASON STOP, in an organ. [ORGAN.]'

DIAPENTE, in Greek music; the interval of the fifth.

DIAPER, a kind of textile fabric, formed either of linen or cotton, or a mixture of the two, upon the face of which a figured pattern is produced by a peculiar mode of twilling, or tweeling. Diapers, which, excepting damasks, are the most ornamental kind of twilled cloths, are chiefly used for table-linen, fine towels, &c.

"The word diaper," observes Mr. Planché, in his 'History of British Costume,' "is derived by some writers from 'd'Ipres,' that is, 'of Ypres,' a town in Flanders, famous for its manufactory of rich stuffs and fine linen before the year 1200." "Ducange," he adds, "derives it from the Italian 'diaspro,' the jasper, which it resembles in its shifting lights; but the first is by far the most plausible conjecture; and though we read of diapers of Antioch, it is only because Ypres having given its name to its peculiar manufacture, any similar cloth received the same appellation."

In decorative painting, and in the ornamenting of glass, the term *diapering* is sometimes applied to a small delicate pattern introduced to diminish the appearance of baldness where a considerable space is covered with one colour, and thus to relieve the eye, without forming any part of the main design. In heraldic painting, especially, it is often resorted to, particularly where the juxtaposition of considerable masses of black and white might prove unsightly; but in all such cases it should be remembered that the diapering forms no part of the heraldic bearing.

DIAPHANOUS. [Transparency].

DIAPHORETICS, or SUDORIFICS, are agents which increase the natural exhalation of the skin, or restore it when suppressed. Nothing better exemplifies the doctrine that remedies are only relative agents than this class of medicines, as their power to produce perspirations depends invariably upon the state of the patient and the circumstances in which he is placed, such as the temperature and humidity of the air by which he is surrounded. Many medicines which cause a flow of perspiration when the patient is kept warm, will produce, when he is in a cool temperature, an increased action of the kidneys and an augmented secretion of urine.

Their effects as diaphoretics are attempted to be accounted for by reference to two principles; 1, by increasing the action of the cutaneous vessels; 2, by increasing the vascular action of the whole system. Those diaphoretic remedies which seem to act according to the first principle produce their effects either by external application, such as the stimulus of heat, especially as proved by the hot-air bath, or as medicinal substances which enter the circulation and stimulate the cutaneous vessels by contact, such as mercurial preparations, some saline diaphoretics, and, most markedly, sulphur, which is evidently carried undecomposed to the cutaneous vessels and excreted by them; or, lastly, by acting on the surface sympathetically through the medium of the stomach, such as warm drinks, antimonial preparations, &c.

Those diaphoretic agents which seem to act according to the second principle are:—violent muscular exercise, carbonate of ammonia, guiacum, alcoholic stimulants, &c.

Diaphoretics are in general used to restore the cutaneous discharge when, from the action of cold or wet upon the system, it has been suppressed, and accordingly they are useful in common catarrh, rheumatism, or diarrhœa proceeding from cold. They are likewise of great service in fevers, the restoration of the secretion of the skin, if it be warm and gentle, not cold and clammy, often proving critical, and the precursor of recovery. In many cutaneous diseases diaphoretics are valuable agents, and for this purpose baths, either the natural warm baths or vapour baths, are used; but in such diseases the perspiration produced by exercise, or during a course of training, is decidedly the best diaphoretic. Some forms of indigestion are relieved or cured by causing an increased action of the skin, to effect which exercise is likewise the best agent.

It is worthy of remark, that the profuse and wasting perspirations which accompany the hectic of consumption are frequently more effectually checked by diaphoretics, especially the compound ipecacuan powder, than by any other means, except oxide of zinc.

(Young *on Consumption*.)

DIARRHŒA (διάῤῥοια), flux, looseness, purging, the frequent discharge from the bowels of more limpid stools than natural. The most obvious and common cause of this disease is the direct application of some stimulating substance to the inner or mucous surface of some portion of the alimentary canal, as articles of food and drink of too stimulating a quality, or, though wholesome in kind, taken in too large a quantity. Undressed or indigestible vegetables, whether acid or sweet, cucumbers, melons, mushrooms, different kinds of salads, fruits, especially plums, stale and decayed vegetables, animal food approaching to the putrescent state, as stale fish, high game, &c., contain matters either not easily digested, or when digested of so stimulating a quality as to irritate the mucous surface of the intestine, and to produce diarrhœa. Water tainted with putrid vegetable or animal matters, or loaded with certain kinds of living or dead animalcules, is no uncommon cause of diarrhœa. When a great mixture of different kinds of food and drink, in large quantities, though wholesome in kind, is taken into the stomach at one meal, it often produces a sudden attack of diarrhœa. Even a draught of cold water, beer, or milk, especially if the individual be overheated at the time, will often almost immediately occasion the same result. Soured or turned milk is a frequent source of diarrhœa amongst children. Many medicines and poisons are substances which prove directly and powerfully irritating to the stomach and intestines. The large class of purgative medicines and the poisons called irritants are of this kind. Purgative medicines, given in a certain quantity and at certain intervals ascertained by experience, produce a certain degree of diarrhœa, which the physician purposely excites for the accomplishment of various objects. Given in very large doses, or in ordinary doses when the system is in a state of peculiar irritability, they sometimes occasion an excessive diarrhœa, which continues longer than usual, and so produce that species of diarrhœa which is called hypercatharsis.

In the state of health various fluids are poured into the stomach and alimentary canal for the purpose of dissolving the aliment and assisting in its assimilation. To accomplish the purpose for which they are secreted from the common mass of blood, these fluids must be in certain quantity, and must possess a certain degree of stimulating power. But in various states of the system, from being bland in their sensible properties, and only moderately stimulating in physiological action, they become greatly increased in quantity, and highly irritating in quality. Of these fluids the principal are the gastric, the intestinal, the pancreatic, and the biliary. The secretion of the gastric juice may be altered in quantity and quality, in consequence of which it may be incapable of properly dissolving the aliment, which therefore may be sent from the stomach into the intestines in an acrid and irritating state, and so produce diarrhœa. The pancreatic juice may also be altered in quantity and quality, and become highly irritating; and the bile is sometimes poured out in greater quantity than usual, and of a more than ordinary acrid quality, and in both ways is a frequent cause of diarrhœa. Moreover, the entire surface of the stomach and intestines is crowded with secreting organs, mucous follicles, from which a quantity of fluid is constantly poured out, constituting the chief portion of the evacuations passed when little or no food has been taken, and which probably also affords the principal part of the matter of the liquid stools that occur in diarrhœa. In many states of the system, and from numerous irritating substances applied to their surfaces, the secretion of these bodies becomes excessive in degree, and highly acrid and irritating in its nature.

The quantity of matter from this source may be indefinitely increased by whatever is capable of occasioning a greater efflux of blood than natural to the mucous surface of the alimentary canal. Hence it may be superinduced by all the other causes of diarrhœa—indigestible food, wholesome food in too large a quantity, disordered states of the digestive fluids, &c., and from increased afflux of fluids from other parts of the system, as from cold applied to the surface of the body and suppressing perspiration, which may determine a greater quantity of fluids to the intestines. Great alternations of temperature will, in many constitutions, produce the same result. Suppressed evacuations, checked menstruation, the retrocession of eruptive diseases, as measles, scarlatina, &c., are often immediately followed by diarrhœa. Even mental emotion is capable of producing it in some irritable and nervous constitutions to a great degree; and when under the influence of such emotions, the slightest excess in food or drink, or the slightest quantity of irritating aliment, will be succeeded by numerous and liquid stools. Irritation in a distant part of the body often induces increased action of the intestines, and occasionally diarrhœa, as the irritation of the gum in dentition. The mucous surface of the whole alimentary canal is highly sensitive and irritable in infants and children, and food improper in quantity or quality is exceedingly apt to induce diarrhœa in them, and if the irritation in the stomach and intestines from this cause be kept up long, irreparable and fatal disease is sure to be induced. Slight errors in diet on the part of the mother, and even an irritable state of mind, will disorder her milk to such a degree as to produce distressing diarrhœa in her infant. The excitability of the capillary arteries, the mobility of the muscular fibres, and the sensibility of the whole nervous system during the early periods of life, render the young much more susceptible to all the causes of diarrhœa than the adolescent and the adult; and the more tender the age the greater this susceptibility.

By whatever cause diarrhœa may be excited, it is seldom that the increased discharge of liquid stools from the intestines is the only symptom present. It is commonly preceded by nausea, and in general more or less uneasiness is felt in the stomach and intestines, which sometimes amounts to severe griping pain, often accompanied with flatulence. In severe cases the abdomen is distended, and even tender to the touch; the nausea passes into vomiting; and the pain, especially around the navel or in the course of the colon, becomes intense, somewhat relieved, perhaps, after each evacuation, but soon returning with undiminished severity. The number of evacuations may vary from three or four to twenty or thirty in the twenty-four hours. Of course the sudden loss of so large a portion of the more fluid part of the blood as is contained in these watery evacuations deprives the system of a proportionate quantity of stimulating and nutritive matter, and accordingly there is often great prostration of strength, and a striking expression in the countenance and attitude of languor and debility. In slight cases the pulse is little if at all affected; but when the pain is severe and the discharge copious, the pulse is quickened, and at an advanced stage of the attack is generally small, weak, and much increased in frequency. The tongue is loaded, and in certain forms of the disease is intensely red at the edges and tip, and the papillæ are large, prominent, and of a bright red colour, shining through a thick coat of fur. The urine is generally diminished in quantity. The skin, at first hot, towards the termination of the attack is unusually cold and chilly, and is peculiarly incapable of resisting the influence of a cold and damp atmosphere.

The nature of the matters contained in the evacuations varies remarkably, and affords important indications of the seat and state of the disease. Several varieties of the disease have indeed been founded on those appearances, and diarrhœa has accordingly been divided into fæculent, bilious, mucous, serous, chylous, lienteric, &c., but the causes of the disease afford more fixed and determinate characters for its distribution into species. Of these there are commonly enumerated the following: diarrhœa *crapulosa*, from food improper in quality or quantity; diarrhœa *biliosa*, from bile more abundant or more acrid than natural, as from the heat of summer and autumn, co-operating with errors in diet; diarrhœa *serosa*, from increased vascular action of the mucous surface of the alimentary canal, induced by whatever occasions a preternatural afflux of blood to the mucous surface; diarrhœa *mucosa*, from increased secretion of the mucous follicles, which may be induced by almost any of the ordinary exciting causes of diarrhœa; diarrhœa *lienterica*, the aliment passing in the evacuations almost unaltered, occurring principally in children about the first and between the first and second dentition, and occasioned by the ordinary exciting causes of diarrhœa.

The duration of this disease must of course be materially influenced by the persistence of the cause that excites it. Its ordinary varieties being generally dependent on temporary causes, are of short duration; but the increased secretion of bile by the liver, and of mucus by the mucous follicles, and the irritation of the intestinal canal from dentition, may be protracted to an indefinite period; and the disease dependent on the excited state of these organs may consequently become chronic, continuing for months together to harass the patient and enfeeble the constitution. In these cases, when a cure is apparently effected, very slight causes are capable of bringing back the disease; and during the period of convalescence the utmost caution is always necessary to avoid errors in diet and any exposure to cold or wet.

The immediate danger from a very severe attack of diarrhœa, or from its passing from the acute into the chronic state, is, that it should terminate in acute inflammation of the bowels (enteritis); or chronic inflammation and ulceration of the bowels (dysentery); or intus-susception (the passing of one convolution of the intestines into another), induced by the increased peristaltic action of the bowels; or enlargement, hardening, and obstruction of the mesenteric glands, and the consequent wasting of the body (marasmus), one of the most common forms of disease by which the existence of infants and children is cut short.

There are several diseases with which diarrhœa may be confounded, from which it is important that it should be distinguished. From the far more serious malady termed dysentery it is distinguished by the absence of fever, by the absence of blood in the evacuations, and by the absence of the painful, distressing, and ineffectual desire to evacuate the contents of the bowels which is called tenesmus. It is distinguished from cholera by the absence of spasms of the muscles, so constant and distressing in the latter disease, by the slighter degree or the total absence of vomiting, and by the milder character and the much less rapid progress of the entire disease. But the bilious and even the pestilential cholera frequently commence with one or other of the preceding forms of diarrhœa. Life often depends on the clearness and promptitude with which the diagnosis is made between diarrhœa from irritation, constituting the crapulous and bilious forms of the disease, and the diarrhœa from inflammation, which often appears under the serous and mucous forms. The diagnosis is chiefly to be drawn from the marked difference in the constitutional symptoms when the diarrhœa is the consequence of an inflammatory state of the internal surface of the intestines. In this case there is always present a greater or less degree of fever; the skin is hot, or alternately hot and chilly; the pulse is more or less excited, and the strength prostrate. The pain in the bowels is obscure and dull rather than griping, the abdomen is tender on pressure, and it is in this case more especially that the tongue is preternaturally red at the edges and the tip, and that its papillæ are enlarged and red.

Though diarrhœa is often a trifling disease, and even a remedial means adopted by nature to prevent the occurrence of more serious evils, yet the serous and mucous forms of it, more especially when they pass into a chronic state, are apt to terminate in dangerous and fatal maladies, and their management requires great and persevering care. Instances are by no means unfrequent in which the ultimate event proves fatal, in consequence of their neglect, or of the medical treatment and the remedies being injudicious. Indeed the treatment of diarrhœa in general requires much discrimination, for a very trifling form of it is easily converted by mismanagement into a highly dangerous disease. The chief difficulty is to detect the exact nature of the exciting cause, and the exact condition of the excited organ, which alone can guide to the selection of one of two opposite plans of treatment, the administration of purgative or of opiate medicines. If the irritation arise from too large a quantity of stimulating food and drink, abstinence alone is sufficient to effect a cure; but if, notwithstanding the abstinence from food, the disease continue, it is necessary to ascertain whether the irritation be kept up by the retention of irritating matters, or whether the alimentary canal itself be in a preternaturally irritable and excited state. If the former, purgative medicine of some kind or other is indispensable, but the choice of the purgative is by no means a matter of indifference. It should have the power of evacuating the contents of the bowels without irritating the mucous surface. For this purpose castor-oil is one of the best medicines; or, if a somewhat stronger purgative be required, infusion of senna with manna. It is often attended with the best effects to combine a few drops of laudanum with the aperient. When the irritating contents of the stomach and intestines are removed, a mild and frequently repeated sedative should be prescribed, one of the best of which consists of two drachms of almond oil with two drachms of mucilage of gum arabic in an ounce of rose or peppermint water, with from five to ten drops (according to the severity of the case) of laudanum, or half a drachm or more of the tincture of hyoscyamus. If the secretions are disordered, five grains of blue pill or of hydrargyrum cum creta, with the same quantity of the compound powder of ipecacuanha, taken every night, or every other night, at bed-time, with a tea-spoonful of castor-oil, containing a few drops of laudanum, the morning following, will soon restore them to a healthy state. Of course the diet should consist only of the mildest alimentary substances; for as long as the alimentary canal continues irritable, food and drink, even of the ordinary stimulating properties, will keep up or re-excite the diarrhœa.

The exciting cause of the biliary variety of diarrhœa is often inflammation of the liver (hepatitis). When there are present any indications of this, blood-letting, or local bleeding by cupping or leeches, must precede all other remedies; and the abstraction of blood must be repeated at short intervals until the inflammatory state of the liver is removed; then mild mercurials, with mild purgatives, are necessary. This is by no means a variety of diarrhœa which can be cured by opiates. The exhibition of any remedies of this class, which, when judiciously managed, are sometimes highly advantageous, requires peculiar discrimination and skill. In the serous and mucous diarrhœa, when there is present no proper fæculent matter, all this having been previously discharged, it is absurd to give purgatives; such medicines can only still further irritate the over-excited organs. Leeches to the abdomen, the warm bath, demulcents with opiates, the chalk mixture, and the strictest regulation of the diet, are necessary.

The diarrhœa, so easily excited, so constantly present, in infants and young children, requires a peculiarly cautious management. When it is connected with dentition it is pregnant with danger to stop the discharge, or even to restrain it, unless it becomes excessive, and then it should be moderated, not stopped; and the mildest means should be employed to accomplish this object, which should never be attempted without at the same time paying the strictest attention to the diet, air, and exercise of the child. Death is often produced in infants at this critical period of the infant's life by the exhibition of opiates to stop this discharge. The proper remedies are the choice of the blandest articles of food, the avoidance of over-feeding, two or three grains of hydrargyrum cum creta at night, and the tepid bath.

DIARY, from the Latin *Diarium*, which again is from *Dies*, a day. The original and proper meaning of the word *Diarium* among the Romans was the daily allowance made to slaves for their sustenance, as *Menstruum* was their monthly allowance. *Diurnum* was another word for the same thing. [ACTA DIURNA.] In later times however either word came to be used for a note-book, or other register of daily occurrences, which had formerly been called (after the Greek) an ephemeris. It is only in the sense of a daily register that the word diary is used in English; and, naturally enough, it is commonly understood to imply specifically a register of occurrences in which the writer has had a personal share, or which have at least in some sort come under his own observation by having happened in his own time. For instance, although a history of the transactions of a former age, composed in a particular form, might be entitled annals, such a history, however minute, would scarcely in any case receive the name of a diary. A diary is etymologically the same thing with a day-book or journal; the latter word being a modernised form of diurnum, as diary is of the synonymous diarium of the same parentage. The French language has only the form *journal*; the Italian, like the English, has both forms, *diario* from *diarium*, *giornale* from *diurnum*, both ultimately from *dies*.

DIASCHI'SMA, a term employed in ancient and in speculative Music, but not in practical use among modern musicians. It is the half of a minor semitone or diesis. [DIESIS.]

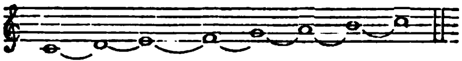
DIASTASE, a peculiar ferment formed during germination. It is prepared by reducing freshly germinated barley into a pulp, with half its weight of water, and then pressing out the liquor strongly. To the clear liquid just sufficient alcohol is to be added to destroy its viscidity, and allow of its being filtered; by this an azotised substance is precipitated, which must be considered as vegetable albumen, since it coagulates at 167° Fahr. Having separated this, alcohol is to be again added as long at the liquid becomes turbid; the precipitate is to be purified by solution in water and precipitation by alcohol repeatedly; the precipitate is at last to be dried in thin layers upon glass at a temperature between 104° and 122° Fahr.

The properties of diastase are the following: It is solid, white, not crystalline, soluble in water, but insoluble in moderately strong alcohol; the aqueous solution is nearly tasteless, and without any chemical action, not precipitating subacetate of lead. The aqueous solution quickly changes, becoming acid; dry diastase undergoes the same change in a longer time, but when boiled in water the alteration is immediate. Common malt is stated in general not to contain more than 1-500th of its weight of diastase; one part of it is sufficient to convert 2000 parts of starch, thickened with water, into a mixture consisting of much dextrine and a little sugar. It has not yet been obtained absolutely pure. [FERMENT.]

DIATESSARON, in Greek music, the interval of the fourth.

DIATHERMANISM. A body which is transparent to light is said to be *diaphanous:* one which is transparent to heat is said to be *diathermanous*, and the branch of science which treats of such bodies is called *diathermanism*. Bodies which do not transmit heat, are said to be *athermanous*. [HEAT.]

DIATON'IC, in Music (διὰ, *through*, and τόνος, *a tone*), a term applied to the first of the three ancient genera, and of the three modern scales, but in both cases rather improperly, because the intervals of the Greek genus and of the scale now in use consist not only of tones, but also of semitones. The *Major Diatonic Scale* of the moderns proceeds thus:—



The Diatonic genus of the Greeks, as exhibited in their several *modes*, comprised five tones and two semitones, differently disposed: that of the Lydian mode, according to Sir Francis Styles ('Transactions of the Royal Society,' 1760), corresponded, as regards the position of the intervals, to our major diatonic scale. [SCALE.]

DIBENZANILIDE. Synonymous with *phenylbibenzamine*, *dibenzöyl-phenylamide*, and *phenyl-dibenzamide*. [BENZOIC GROUP; *Phenylbibenzamine*.]

DIBENZÖYLIMIDE. ($C_{28}H_{13}NO_2$). A yellow crystalline body, obtained by the action of ammonia upon oil of bitter almonds.

DIBENZÖYLPHENYLAMIDE. [DIBENZANILIDE.]

DIBROMANILINE. [ANILINE.]

DICETYLANILINE. [CETYL, *Compounds of*.]

DICHLORANILINE. [ANILINE.]

DICHLORISATIN. [INDIGO.]

DICHROISM. When light is transmitted through a crystallised body, and its colour is found to vary according to the position of its axis with respect to the incident pencil of light, the crystal is said to possess *dichroism*, or double colour, from δις and χρόα. [LIGHT; POLARISATION.]

DICTA'TOR was the highest extraordinary magistrate in the Roman republic. Though the name obviously contains the element *dic* (from *dīco*), it was doubted by the Roman writers whether the title had reference to the mode of his nomination or to his power. He was also called by the old name of Magister Populi, and in Greek δισύπατος, or "double consul." After the expulsion of the kings the consulship was established. The two consuls possessed the same power as the kings in the administration of the state and the command of the army, yet their authority was subject to some restrictions, and principally by the appeal that could be made from their decisions. [CONSUL.] The two consuls, possessing equal authority, often differed in their views and opinions; a circumstance which necessarily caused jealousy and disunion, particularly in the command of the army when on active service. In extraordinary emergencies, the republic therefore required a single magistrate, invested with ample authority. Such circumstances led to the establishment of the dictatorship. The first dictator was created about the year 253 A.U.C., or 501 B.C. (Liv. ii. 18.)

The dictator united in himself the power of the two consuls; and the authority of all other magistrates, except that of the tribunes, ceased as soon as he was appointed. He possessed the whole administrative power of the state, and the command of the army without any restrictions. (Dion Cassius, according to Zonares, vii. 13, where a reference to a lost book of Dion is given. Dion Halic., v. 70, 73.) He had the power of life and death, and there was no appeal from his decision. Both within and without the city he was attended by twenty-four lictors, with their fasces and axes. The dictators were not chosen, like the other magistrates, in the comitia, but they were appointed by one of the consuls, in conformity with a vote of the senate. Sometimes the senate itself appointed the dictator, and in some instances he was elected by the comitia. At first he was taken only from the patrician order, but afterwards (B.C. 356) also from the plebeians. After his election, the dictator nominated the master of horse (magister equitum), who commanded under him. It was only when the state was menaced by sudden danger from within or without that a dictator was nominated; but in the course of time a dictator was elected to preside at the elections in the comitia, when the consuls were abroad, and therefore could not preside; and also on some other public solemnities. (Liv. vii. 3; viii. 18 and 23.) The dictator continued in office for six months, but he commonly resigned as soon as the danger was over which had led to the nomination. The dictator was not allowed to leave Italy, or to enter the city on horseback. Yet there are instances in which the dictator left Italy, as for example in the first Punic War, when a dictator commanded in Sicily. The rule that he should continue in office only six months was also neglected; Sylla and Julius Cæsar were nominated perpetual dictators, the former in the year 81 B.C., and the other after his victory at Pharsalus. The office seems never to have been filled from B.C. 202, to the time when Sylla, the head of the oligarchical party, was made perpetual dictator. J. Cæsar, who was the head of the democratic party, or perhaps rather chose that party merely that he might, by being at the head of one of the great divisions which distracted the state, prepare the way for his own unlimited power, after being dictator five times, became dictator for life. Augustus declined the office, though offered to him by the people (Suetonius, 'Aug.' 52), and the title of dictator was never assumed by the emperors of Rome.

These are the received opinions as to the Roman dictators; but in Niebuhr's Roman history we find other views of the subject, to which we shall briefly advert. According to him, the dictatorship was of Latin origin and was introduced from the Latins among the Romans. The object of the Roman dictatorship was to evade the Valerian laws, and to establish the power of the patricians over the plebeians; for the appeal granted by those laws was from the sentence of the consuls, and not from that of the dictator. The later Romans had but an indistinct knowledge of the dictatorship of the ancient constitution. Dion Cassius is in error, when (without excepting the patricians) he asserts that in no instance was there a right of appeal from the dictator, and that he could condemn knights and senators to death without a trial. Dionysius is also in error, when he says, that the dictator decided on every measure according to his own pleasure. It is incorrect to suppose that the appointment of the dictator in all cases rested with one of the consuls; for the conferring of kingly power (such as that of the dictator was) could never have been intrusted to a single person. The pontifical books have preserved so much as this, that the dictator was nominated by the senate, and that the nomination was approved by the people. As the plebeians increased in power, the dictatorship was seldom required, and then only for matters of less importance; and in such cases the nomination was left to the consuls.

(For a general sketch of the dictatorial power, the reader may consult Creuzer, *Abriss der Römischen Antiquitäten*, &c., Leipzig, 1824; Niebuhr's chapter *on the Dictator*, and his *Remarks on the Relationship of the Dictator and the Master of the Horse*, vol. i., Engl. Trans.)

DICTIONARY, the English form of *Dictionarium*, a word of low or modern Latinity, which from its etymology should signify properly a book of phrases or modes of expression. The term however has been generally applied to any work which professes to communicate information on an entire subject, or entire branch of a subject, under words or heads digested in the order of the alphabet. This alphabetical arrangement appears to be the distinctive peculiarity of what is called a dictionary; but to constitute the work a dictionary, it should seem that there must also be attached to each of the terms, so arranged, some explanation or interpretation. Thus, an index, in which words or titles are merely put down in alphabetical order, with nothing more than a reference to some page or passage appended to each, is not a dictionary. The alphabet itself is not a dictionary. Again, a dictionary, however arbitrary or artificial may be the order in which its parts are distributed, must profess some unity and completeness of design. It must profess, as has been said, to go over a whole subject, or field of knowledge, of greater or less extent. Thus a mere list of miscellaneous particulars, even with explanatory remarks or comments annexed, is not a dictionary, but a catalogue. A collection of plays or of pamphlets might be arranged in the order of the alphabet, but would not on that account make a dictionary. That name is not applicable, and is never given, even to the most extensive enumeration and account of things which are merely brought together, without constituting when collected a natural system or complete body of knowledge.

Within the limitations noted, the term dictionary is applied to works on all kinds of subjects, and with every diversity of object. Dictionaries have sometimes been divided into three classes or descriptions: 1. Dictionaries of words. 2. Dictionaries of facts. 3. Dictionaries of things. And although objections may be made to the principle of this distribution (as has been done by D'Alembert in the 'Encyclopédie,' article *Dictionnaire*), it is sufficiently convenient for practical purposes, and we shall therefore adhere to it in what we have now to say.

I. *Dictionaries of Words.*—This is the original application of the word dictionary, and the sense in which it is commonly understood when it stands alone. It answers in this sense to the Greek lexicon, and although etymologically that term, like the term dictionary, ought perhaps to signify a book of phrases or modes of expression, yet among the Greeks it seems rather to have denoted a book that explains words. A dictionary or lexicon, indeed, usually combines an explanation of phrases with an explanation of single words. When it contains nothing beyond an explanation or translation of single words, it is more distinctively called a vocabulary or word-book. The word vocabularium, we believe, is not found in the Latin of antiquity, any more than dictionarium. A glossary, in Latin *glossarium*, which is used by the later classics, from the Greek *glossa* (γλῶσσα), "a tongue" or "language," is generally understood to mean an explanation, more or less diffuse, of terms of unusual occurrence. Among the Greeks themselves, indeed, *glossa* was used for a foreign or otherwise peculiar word or form of expression. (Aristot., 'Poet.,' c. 38.) As there is nothing in the etymology of the term glossary, however, to confine it to this explanation, many examples may be found of its employment in a more extended sense. Some dictionaries profess to have more peculiarly for their object the explanation or interpretation of phrases; such, for example, as the well-known volume on the Latin language entitled 'Phraseologia Generalis,' by William Robertson, 8vo, Camb. 1681; and Tarver's 'Phraseological Dictionary,' in French and English, 1850. Some dictionaries and vocabularies apply only to some particular author or work; such as Damm's Lexicons or Concordances, as they are called, of Homer and Pindar, since combined into the 'Lexicon Homerico-Pindaricum,' the 'Lexicon Ciceronianum' of Marius Nizolius, &c. Such dictionaries, when well compiled, are among the most valuable aids the student can avail himself of. Nor are they of use only in studying the authors of antiquity; the works of some modern writers have been very ably illustrated in this way, as, for instance, by Archdeacon Nares in his glossary to Shakspere and his Contemporaries, 4to, London, 1822. Even a mere verbal index, with little or no explanation of the meanings of the words, is often much more useful than a professedly interpreting dictionary, by merely bringing together or pointing out by reference the different passages in which each word is used, so that they may be compared with one another. Such mere indexes as those attached to the 'Delphin Classics' are of great value in this way, in addition to their proper use of enabling any passage to be found of which even a single word is recollected. Few of our English classics have been illustrated by such complete verbal indexes; there is one to 'Milton's Paradise Lost,' 12mo, London, 1741. Ayscough's 'Index to Shakspere' is only an index to the "remarkable" passages and words; and although its professed design is "to point out the different meanings to which the words are applied," it is not very successfully compiled for that purpose. Mrs. Cowden Clarke's Concordance is far more complete. Indexes of this description serve in fact the same purpose with Concordances, although that term has been for the most part confined to works relating to the Scriptures. [CONCORDANCE.] Some works entitled dictionaries, indeed, comprehend concordances more or less complete; as, for instance, Schleusner's 'Novum Lexicon Græco-Latinum in Novum Testamentum,' and the Ionic lexicon of Schweighäuser, which is a sort of concordance to Herodotus, and that to Polybius by the same scholar.

Some of these dictionaries to particular authors, or works, have exclusively or principally in view the illustration of the style of the author, or his use of particular words. One of the best of these is Ernesti's 'Index Latinitatis Philologico-Criticus' to Cicero. This work in fact, although styled merely an index, is much more a dictionary of interpretation and commentary than the lexicon just mentioned of Nizolius, which, however, is much the more minute and extensive index of the two. The instance may serve to show with what latitude the two titles are applied. And the title of index, it may be added, has been sometimes given to works which are not really indexes in any respect, but simply dictionaries or vocabularies. We may mention as an example, 'Olai Vereli Index Linguæ Veteris Scytho-Scandicæ, sive Gothicæ, opera Olai Rudbeckii editus,' fol. Upsalæ, 1691, which is merely a vocabulary of the Gothic. Dictionaries of languages have also been published under many other titles. A thesaurus, or treasury, is a very common title of such a book. Thus Faber's Latin dictionary is styled 'Thesaurus Eruditionis Scholasticæ,' and H. Stephens' Greek lexicon is entitled 'Thesaurus Græcæ Linguæ.' Edward Philips entitles his English dictionary a 'World of Words.' In some cases an attempt has been made by means of a dictionary or index, not only to point out the writer's use of particular words, or their meaning in particular passages of his works, but also to give an abstract of his text. This has been done in the index to Hippocrates, by Fœsius, entitled 'Œconomia Hippocratis Alphabeti serie distincta, in qua Dictionum apud Hippocratem omnium, præsertim obscuriorum, usus explicatur, et velut ex amplissimo Penu depromitur, ita ut Lexicon Hippocrateum merito dici possit,' fol. Francf. 1688. In 1677, Elisha Cole published in London, in 8vo, 'An English Dictionary; explaining the difficult terms that are used in Divinity, Husbandry, Physick, Philosophy, Law, Navigation, Mathematics, and other Arts and Sciences.' Of dictionaries of words also, some are dictionaries of etymologies, some of the quantities of syllables (as the common Latin 'Gradus ad Parnassum,' and Morell's 'Thesaurus Græcæ Poeseos, sive Lexicon Græco-Prosodiacum,' improved and enlarged by Maltby); some of terminations (as in English, Walker's 'Rhyming Dictionary'), and Hoogeveen's 'Dictionarium Analogicum Linguæ Græcæ.' Some dictionaries of the oriental tongues and of the Greek tongue exhibit the words arranged according to their supposed roots; and some Latin dictionaries have also been constructed upon this plan. Of professed dictionaries of derivations one of the most elaborate, though it is far from being a correct or philosophical work, is the 'Entymologicon Linguæ Latinæ' of G. J. Vossius. Others are the 'Dictionnaire Etymologique de la Langue Française,' of Menage; the 'Origines de la Langue Italienne,' of the same author; the 'Etymologicon Linguæ Anglicanæ,' of Stephen Skinner, fol. 1671: and the 'Etymologicon Anglicanum' of Francis Junius, fol., Oxon, 1743. A very ambitious attempt has been made by Mr. Whiter in his 'Etymologicon Magnum, or Universal Etymological Dictionary on a new plan,' 3 vols. 4to., Camb. 1800—1822, to construct a dictionary of the elements of all human language. Mr. Booth, in his 'Analytical Dictionary of the English Language,' has set an example of perhaps the happiest mode in which an account of words can be given according to their etymologies or affinities. By making each radical term the text of a short essay, in the course of which the history of all its derived and connected terms is traced and illustrated by quotations, references to manners and customs, and anecdotes of various kinds, the writer has rendered his dictionary as entertaining as it is instructive, and adapted it not only for occasional consultation but for continuous reading. Dr. Chevenix Trench has likewise made valuable additions in this direction.

Any account of the dictionaries of particular tongues would be out of place here. There is a 'Table Alphabétique des Dictionnaires,' by Durey de Noinville, published in 1758, which however is asserted to be very incomplete, even for that time. A very elaborate dissertation on lexicons and glossaries in general, and on those of the Greek language in particular, by P. J. Maussacus, is inserted in most of the editions of the Greek lexicon of Harpocration, entitled 'Lexicon Decem Oratorum;' and the same subject has also been treated by several other writers who are enumerated in Morhoff's 'Polyhistor,' lib. iv. cap. 7. In the portion of Morhoff's third book, from chapter 4th to chapter 9th inclusive (vol. i. pp. 743–830, edit. 1747), is given an account of the principal dictionaries of the modern European tongues, of the oriental tongues, of the Greek, and of the Latin tongues. See also De Bure's 'Bibliographie Instructive,' vol. iii., p. 1–86.

In some dictionaries the words are explained in the same language to which they belong; in many others the words of one language are interpreted by corresponding words in another language. In some the interpretation or translation is into several languages; as, for instance, in Minsheu's 'Dictionary of Eleven Languages, namely, English, Welsh, German, Dutch, French, Italian, Spanish, Portuguese, Latin, Greek, and Hebrew,' fol. London, 1617: and in a dictionary printed at St. Petersburg in 3 vols. 4to., in 1785, in which the words and phrases are given in French, German, Russian, and Latin.

Although, as Maussacus in his Critical Dissertation just noticed has taken great pains to prove, books both of γλῶσσαι, or unusual words, and of λέξεις, or idioms, are frequently referred to or mentioned by the Greek and Latin grammarians and other writers, it does not clearly appear that all of these were what we should now call dictionaries, that is to say, were collections of vocables and phrases alphabetically arranged. The oldest extant Greek lexicographer is Appollonius the Sophist, a contemporary of Augustus; his work entitled Λέξεις Ὁμηρικαί, or 'Homeric Words,' though much interpolated, is very useful. All the other original Greek lexicons and glossaries we have, such as the 'Onomasticon' (or collection of Synonyms) of Julius Pollux, the lexicons of Suidas, Harpocration, and Hesychius, and the 'Etymologicon Magnum,' sometimes attributed to Marcus Musurus, although of the authors of some of them the exact age is disputed, were undoubtedly compiled subsequent, and most of them probably long subsequent to the commencement of the Christian era. It is supposed, indeed, that they were founded upon older compilations of the same kind; but of the form of those lost works we know nothing. It may be reasonably doubted if either the Greeks or Romans were in the habit of making use of dictionaries in studying a foreign language or dialect, as has been the general practice in modern times. They would seem rather to have uniformly followed what may be called the natural method of learning the language from conversation with those who spoke it, being the method by which we all learn the language we acquire both most easily and most perfectly, our mother tongue, and that by which alone a real knowledge and command of any language can be acquired. Although, however, the utility of a general dictionary of a language as an instrument either for teaching the language to youth in schools, or for enabling a student to master it in any circumstances, may well be questioned, there are obvious considerations which make it desirable that we should possess such dictionaries of all languages. When a dictionary of a language professes to be more than a mere vocabulary, it is usual for it to contain along with the interpretation or explanation of the meaning of each word, some account of its etymology or derivation, and also of its grammatical usage. Except when the dictionary is exclusively etymological, perhaps all that ought to be attempted in regard to the foreign extraction of words is to note the language from which each may be supposed to have been immediately borrowed. But merely to append the supposed original word of the foreign language, as is generally done, conveys little valuable information in any case, and is very apt to lead to misconception. If it is desired to exhibit the nature of the change which the forms of the words have undergone in passing from the one tongue to the other, this will be better done by a short statement on the subject once for all, in which the several modes and incidents of the transference should be systematically arranged and illustrated by examples, and the principle of each explained. It would be fully of as much importance however that in every dictionary of a language the connection of each word with other words in the same language, or the native root from which each has sprung, should be distinctly marked whenever it is not obvious. This reference of each word to the proper family to which it belongs contributes more to make its meaning clear and to point out its correct use than any definition can do. And such a notice of the root of the word would naturally lead to, and should be followed by, as precise a statement as possible of its primitive and most simple meaning; after which should come a chronological deduction of the changes it has undergone, as far as they can be traced, both in signification and in form, the whole definition being concluded by an explanation of its metaphorical and other secondary or transferred meanings. If its use in each sense can be illustrated by an example, such quotations are, for various reasons, in the highest degree satisfactory and valuable. Any remarkable uses of the word in particular passages of standard authors ought at least to be adverted to and explained; and a notice of its peculiarities of construction, or the manner in which it is connected with other words in a sentence, should never be omitted. There are some dictionaries in which all this has been attempted, but perhaps scarcely one in which it has been quite satisfactorily executed. Among the most carefully compiled dictionaries of modern languages are that of the Italian, entitled 'Vocabolario degli Academici della Crusca,' extended in the latest editions to 6 vols. fol.; and that of the French, entitled 'Dictionnaire de l'Académie Française.' But in both these works, especially in the latter, the design principally kept in view has been to guard the purity of the language. There is also a Spanish dictionary of great reputation, entitled 'Diccionario de la Lengua Castellana, compuesto por la Real Academia Española,' 6 vols. fol., Madrid, 1726, &c. In English, Johnson's Dictionary has been accounted the standard work of its class ever since its appearance, in 2 vols. fol., 1755; but although it was a great achievement for an individual, and its definitions in particular afford remarkable evidence of its author's ingenuity and command of expression, it is in many respects far from being what a dictionary should be. Its etymological part is very poor; and it is characterised throughout by want of method and of philosophical views. Some useful matter has been added to the edition of the English Dictionary (augmented to 6 vols. 4to.) edited by the Reverend Mr. Todd; but the philosophical character of the work has received no improvement in his hands. Dr. Richardson's Dictionary is formed on the principle of giving all the words consecutively that are derived from the same root. It appeared first in the 'Encyclopædia Britannica,' but was published, enlarged and improved, in 1826. Other dictionaries have been compiled containing collections of obsolete or provincial words. Among them may be mentioned, as belonging to Great Britain, that of Dr. Jamieson, 'An Etymological Dictionary of the Scottish Language,' in 2 vols. 4to, Edinb., 1808; Boucher's 'Glossary of Archaic and Provincial Words; a Supplement to the Dictionaries of the English Language, particularly those of Dr. Johnson and Webster,' which was carried no further than the word Blade, and only one part was published as a specimen, with a well-written introduction, in 4to, in 1832 [BOUCHER, in BIOG. DIV.]; Halliwell's 'Dictionary of Archaic and Provincial Words,' 2 vols. 8vo, 1850; and Thos. Wright's 'Dictionary of Obsolete and Provincial English,' in 2 vols. 8vo, 1857; Crabb's 'Technological Dictionary,' published in 2 vols. 4to, in 1823; and of which a new edition has been published in 1859; a work of a useful character, which might be extended and improved to advantage.

II. *Dictionaries of Facts.* This class comprehends dictionaries of history, biography, mythology, geography, archæology, and all others that deal chiefly or exclusively with events that have happened, or are supposed to have happened, or with facts that exist or have existed. Many of the principal works of this description are enumerated in the article BIOGRAPHY: and under BIBLIOGRAPHY will be found an account of another large division of them. We may here observe that some of the old Greek lexicons already noticed were dictionaries of facts as well as of words; the lexicon of Suidas, for instance, is, in the greater part, made up of fragments of biography, history, and geography, and often contains large extracts from various writers both extant and lost. The work of Stephanus Byzantinus, sometimes entitled 'Εθνικὰ (the Ethnology), more commonly Περὶ Πόλεων (the Book of Cities, or rather of States), is chiefly a geographical and archæological dictionary, and is the oldest compilation of that description that exists. Its meagre details under each head assimilate it in some respects to an imperfect gazetteer. In modern times the number of dictionaries that have appeared, professing to present a view of a more or less extensive field of facts, has been very great. Besides the various historical, biographical, and geographical dictionaries, general and particular, and the bibliographical dictionaries, there are dictionaries of antiquities, of architecture, of heraldry, of painting, of music, of botany, of law, of legal decisions, of commerce, of medicine, of surgery, and of almost every other department of human knowledge. Opinions, indeed, considered historically, are themselves facts, and as such ought to be recorded and arranged in dictionaries as well as other facts. Discussion also often places doubtful facts in a clearer light, and a dictionary may be as convenient a vehicle for such discussion as any other book. But a most useful class of books, of which we have yet scarcely a specimen, would be a set of dictionaries or tabular expositions of facts, and nothing else. They would serve, among other purposes, as maps of the extent and boundaries of the different departments of human knowledge, and most useful directories in the prosecution of all inquiries having in view the enlargement of those boundaries. As of facts some are completely ascertained, others only probable, and others doubtful, three divisions answering to these descriptions might be given under each head, and a fourth might perhaps be advantageously added for improbable or confuted statements, although these last might be more scientifically exhibited in the table or dictionary of the facts forming the history of opinions.

This class of Dictionary, indeed, is becoming much in vogue for special subjects or branches of study; and the following titles of a few of the more characteristic will illustrate their nature:—'Dictionnaire des Sciences Médicales, par une Société de Médecins et Chirurgiens,' edited by F. P. Chauneton and F. V. Mérat, 60 vols, 8vo, Par. 1812-22; 'Universal-Lexikon der Praktischen Medecin und Chirurgie, von Andral Bégin, &c.,' 14 vols. 8vo, Leipz. 1844–48; 'Dictionary of Practical Medicine,' by J. Copland, 3 vols. 8vo, Lond. 1844–58; 'Cyclopædia of Anatomy and Physiology, with Supplementary Volume,' by R. B. Todd, 5 vols. 8vo, Lond. 1835-59; 'Dictionnaire généalogique, héraldique, chronologique et historique,' by M. D. L. C. D[es] B[ois], 7 vols. 12mo, Par., 1757-65; 'Dictionnaire géographique universel. Par une Société de Géographes,' 13 vols. 8vo, Bruxelles, 1839; 'Nouveau Dictionnaire d'histoire naturelle, appliquée aux Arts,' nouvelle ed., 36 vols. 8vo, Par. 1816-19; 'Dictionnaire Classique d'histoire naturelle,' par Audouin, Bourdon, and others, edited by Bory de St. Vincent, 17 vols. 8vo, Paris, 1822-31, of which a 2nd ed. published under the title of 'Nouveau Dictionnaire Classique d'histoire naturelle; ou repertoire des sciences naturelles et physiques. Rédigé par une Société de Naturalistes,' 2e édition, revue par M. B. S., 47 vols. 12mo, with an Atlas in 8vo, Paris, 1844-46; 'Dictionnaire des Sciences Naturelles,' edited by F. Cuvier, 61 vols. of text and 10 of plates, 8vo, Strasb. and Paris, 1816-45—with a 'Supplément et Atlas de Zoologie,' 2 vols. 8vo, Par. 1840-44; 'Dizionario delle Scienze Naturali: tradizione dal Francese, con aggiunte e correzioni,' (with plates) 26 vols. 8vo, Firenze, 1830–51; 'Dictionnaire de l'Industrie manufacturière, commerciale, et agricole,' par Baudrimont, Blanqui, &c., 10 vols. 8vo, Paris, 1831-41; 'Dictionnaire Raisonné de l'Architecture Française du XI au XVI siècle, par Viollet-le-Duc,' in progress; the 'Architectural Dictionary of the Royal Institute of Architects,' also in progress, in large folio; 'Dictionnaire Raisonné du Mobilier, de l'époque Carlovingienne à la Renaissance,' 8vo, Par. 1858, &c. The first part treating of 'Meubles,' is in 1 vol., and is being followed by other vols. on—2° Ustensiles, Outils, Instruments, &c.; 3° Orfèvriere; 4° Habits, Vêtements, Parure; 5° Armes, Equipements Militaires, Harnais; 6° Bijous. 'A Dictionary of Photography,' by T. Sutton, in 1 vol. 8vo, 1858; 'Dictionary of Botanical Terms;' and Page's 'Dictionary of Terms used in Geology,' &c. &c.

III. *Dictionaries of Things.* This, the third class of dictionaries, includes all the abstract sciences, the mixed or applied sciences, the departments of criticism and the fine arts, and the whole range of metaphysical and moral speculation. It is true that some of these subjects cannot be treated of without a reference to facts; but the facts here are not viewed simply as such, but either as subordinate to principles or as modifying their operation. No very rigorous adherence to the limits of a definition, however, is to be expected in a dictionary of any kind, which must in all cases be a somewhat unsystematic performance, and accordingly we have few, if any, dictionaries which are exclusively dictionaries of things in the sense that has just been explained. Many of the dictionaries referred to under the last head are dictionaries of things as well as of facts: that is to say, they contain, mixed up with their statements of facts, expositions or discussions of principles. On the other hand, dictionaries of things are generally also dictionaries of facts, and sometimes lexicons, or dictionaries of words and phrases, in addition. The most important works of this description have been published under the title of Dictionaries of the Arts and Sciences, or Encyclopædias. By the word *ἐγκυκλοπαιδεία*, encyclopædia, the Greeks seem to have understood the whole circle of learning, or of the liberal arts, or instruction therein, the term being so applied under the notion that all the departments of human knowledge were naturally connected together so as to form a sort of circle or complete system. Pliny ('Nat. Hist.' præf.) speaks of the encyclopædia of the Greeks as an expression for the whole field of knowledge: "Jam omnia attingenda, quæ Græci τῆς ἐγκυκλοπαιδείας vocant." Quintilian (i. 10) defines it as the orb or complete circle of human learning: "Orbis illa doctrinæ, quam Græci ἐγκυκλοπαιδείαν vocant." Vitruvius (vi. præf.) describes the encyclios or *ἐγκύκλιος παιδεία* of the Greeks as the discipline of all the branches of learning: "doctrinarum omnium disciplina." It does not appear that the term encyclopædia was ever anciently used as meaning a work treating of all the various kinds of knowledge. It has, however, as just observed, become the common title for such works in modern times. Perhaps it was first so applied by some of the Arabian writers of the middle ages, one of whom at least, Alfarabius, who flourished in the 10th century, is stated to have compiled a general treatise on the sciences, still preserved, under this title. Several such treatises with the same title appeared in Europe about the end of the 16th and beginning of the 17th centuries, the most famous of which was that of John Henry Alstedius, which was first published in 2 vols. fol. in 1630. (See preface to Supplement to 'Encyclopædia Britannica,' and Morhoffii Polyhistor, vol. i. lib. ii. chap. 7, for an account of this and other early encyclopædias.) But none of these works were dictionaries: they were merely collections of treatises, rather resembling such works as Dodsley's 'Preceptor' than answering to the modern notion of an encyclopædia. A much nearer resemblance to the modern encyclopædia is presented by the 'Lexicon Universale Historico-Geographico-Chronologico-Poetico-Philologicum' of Joh. Jac. Hofman, first published at Basle, in 2 vols. fol., 1677, and followed by a 'Continuatio' or Supplement, of the same extent, in 1683; or, the two publications incorporated in 4 vols. fol., Lug. Bat., 1698. The form at least of this work has been generally preserved in our more recent encyclopædias and dictionaries of the arts and sciences, although most of these, by including the principles of science as well as facts, have extended their scope somewhat beyond Hofman's design. His two supplementary volumes, however, embody a great deal of the natural science of his time; and the work altogether contains much curious learning not readily found elsewhere. Although not evidencing any very superior sagacity, penetration, or elegance of scholarship, it is a wonderful performance for an individual, and still remains a most useful book of reference.

The first English "universal dictionary of the arts and sciences" was the 'Lexicon Technicum' of Dr. John Harris, of which the first vol. in fol. appeared at London in 1706, and the second, completing the work, in 1710. It was afterwards extended to three volumes. "With this," says Watt, ('Bibliotheca Britannica'), "originated all the other dictionaries of arts and science and cyclopædias that have since appeared." Harris's Lexicon enjoyed great popularity for a considerable time after its first appearance, as may be inferred from the fact that it passed through five editions in about thirty years; and in the mathematical and physical department especially it is admitted to have been very ably executed. It was not long, however, before it found a rival in Chambers's 'Cyclopædia,' the first edition of which appeared in 2 vols. fol. in 1728. [CHAMBERS, EPHRAIM, in BIOG. DIV.] The professed peculiarity of the new work was, that it proposed to "consider the several matters not only in themselves, but relatively, or as they respect each other; both to treat them as so many wholes, and as so many parts of some greater whole." This was attempted to be done by a system of references from one article to another, so as to connect the subordinate particulars among themselves, and to indicate the great division of knowledge to which each belonged. In this way the work, which, in the seventh edition (1778–85), was extended to 4 vols. fol., contained no complete treatises on any of the sciences, nor other articles of any considerable length. Various other works followed, compiled upon much the same plan, among which were, Barrow's 'New and Universal Dictionary of Arts and Sciences,' in 1 vol. fol., 1751, with a supplemental vol. published in 1754; 'A new and complete Dictionary of Arts and Sciences, by a Society of Gentlemen' (commonly, from the name of the publisher, called Owen's Dictionary), 4 vols., 8vo., 1754; and 'The Complete Dictionary of Arts and Sciences,' in 3 vols. fol., 1766, by the Rev. Henry Croker, Dr. Thomas Williams, and Mr. Samuel Clark.

A work upon a different plan had also appeared in 2 vols. fol. in 1745, by Dr. De Coetlogon, a native of France, naturalised in England, under the title of 'An Universal History of Arts and Sciences, or a Comprehensive Illustration of all Sciences and of all Arts.' This was in fact a dictionary, the subjects being treated in alphabetical order, and Mr. Macvey Napier considers it to have probably suggested the 'Encyclopædia Britannica,' the first edition of which, in 3 vols. 4to., appeared at Edinburgh in 1771. It professed to be compiled "by a Society of Gentlemen in Scotland, upon a new plan, in which the different sciences and arts are digested into distinct treatises or systems." This plan however had been already adopted in Dr. Coetlogon's work. The proprietor and principal compiler of the Edinburgh work was Mr. William Smellie, the printer, a man of much ability and considerable literary attainments. For the subsequent history of the 'Encylopædia Britannica,' which in the fourth edition, completed in 1810, was extended to 20 vols., and to which a Supplement in 6 vols. was added in 1824, we must refer to Mr. Napier's preface. An eighth edition of the work, in which the Supplement is incorporated, is now in course of publication. Of other English Cyclopædias, we may mention the 'Dictionarium Polygraphicum, or the whole body of Arts regularly digested,' in 2 vols. 8vo, London, 1735; the 'English Cyclopædia, being a Collection of Treatises and a Dictionary of Terms illustrative of the Arts and Sciences,' published by Kearsley, in 10 vols. 4to, 1795-1803; E. A. Kendal's 'Pocket Cyclopædia,' 6 vols. 12mo, 1802; and Hall's 'Dictionary of Arts and Sciences, 3 vols. folio. Two others better deserving of notice were next undertaken: the 'Cyclopædia, or a New Universal Dictionary of Arts and Sciences,' conducted by the late Dr. Rees, and commonly known by his name, although professing to be only a new edition of Chambers, begun in 1802, and completed in 45 vols. 4to, (of which 6 were plates) in 1819; and the 'Edinburgh Cyclopædia,' edited by Dr. (now Sir David) Brewster, begun in 1810, and completed in 36 parts, or 18 vols. 4to, in 1830. The 'Encyclopædia Metropolitana was begun in 1818, being announced as a Universal Dictionary of Knowledge on an original plan; comprising the twofold advantages of a philosophical and an alphabetical arrangement. This work was completed in 1846, and is arranged in four divisions; the 1st, comprehending the Pure Sciences; the 2nd, the Mixed and Applied Sciences; the 3rd, the Biographical and Historical articles; and the 4th, the Miscellaneous and Lexicographical articles. 'The Penny Cyclopædia of the Society for the Diffusion of Useful Knowledge' was begun in 1833, published regularly in numbers and in volumes, and completed in 1843; two volumes of Supplement were added in 1847; and a second Supplement in one volume in 1858. The articles in this were all compiled from original sources, and the total expense for the literary labour did not fall short of 45,000*l.* The 'National Cyclopædia,' in 12 vols. 8vo, 1847–51, was an abridgment of the 'Penny Cyclopædia.' Of other works of this class, it will be sufficient to mention W. Nicholson's 'British Cyclopædia,' 6 vols. 8vo, 1807-9; Enfield's 'New Encyclopædia,' 10 vols. 12mo, London, 1809–11; Johnson's and Exley's 'Imperial Encyclopædia,' 4 vols. 4to, London, 1809: Wilkes's 'Encyclopædia Londinensis, or General Dictionary of Arts, Sciences, and Literature,' &c., in 24 vols. 4to, London, 1810-29; Amyas Burrowes's 'Modern Encyclopædia, a general Dictionary of Arts, Sciences, and Literature,' 1816; Miller's 'Encyclopædia Edinensis, or Dictionary of Arts, Sciences, and Miscellaneous Literature,' 6 vols. 4to, Edinburgh, 1816; and the 'Encyclopædia Perthensis, intended to supersede the use of other Books of Reference,' in 23 vols. 8vo, Edinburgh, second edition, 1816; the 'Oxford Encylopædia, or Dictionary of Arts, Sciences, and General Literature,' in 6 vols. 4to, Oxford, 1828; the 'London Encyclopædia, or Universal Dictionary of Science, Art, Literature, and Practical Mechanics,' in 22 vols. 8vo, London, 1829; Partington's 'British Cyclopœdia,' London, 10 vols. 8vo, 1835-38, in four divisions of Arts and Sciences; Biography; Literature, History, Geography, Law, and Politics; and Natural History; and the 'Cyclopædia of Useful Arts,' by C. Tomlinson, in 2 vols. 8vo, 1852.

Pertaining to English literature, as being in the English language, there are also the 'Encyclopædia Americana, a popular Dictionary of Arts, Sciences, Literature, History, Politics, and Biography,' &c., edited by F. Lieber, assisted by E. Wigglesworth, based on the German 'Conversations-Lexikon,' in 14 vols. 8vo, Philadelphia, 1829-43. The German work is also the base of the 'Popular Encyclopædia, or Conversations Lexicon,' in 7 vols. royal 8vo, published by Blackie of Glasgow in 1841; and the 'American Cyclopædia,' edited by George Ripley and Charles A. Dana, of which only four volumes 4to. have yet (1859) appeared, extending to the word Chartres; in the preface to this work special obligation is acknowledged "to the 'English Encyclopædia,' edited by Mr. Charles Knight, whose well-digested summaries, in some instances, have been drawn upon for useful information." The tenth edition of the original work is also the declared base of Chambers's 'Encyclopædia,' now in course of publication. Dr. Lardner's 'Cyclopædia,' a collection of independent works, bound together by nothing but the title, does not belong to this class of works. The 'English Cyclopædia,' commenced in 1853, "in four divisions, of Geography, Natural History, Biography, and Arts and Sciences," is founded upon the copyright of the 'Penny Cyclopædia;' with large additions and corrections, including a new literary outlay quite in proportion to that branch of expenditure on its predecessor.

Of foreign works of this class, perhaps the earliest was that entitled 'Georgii Vallæ Placentini viri clariss. de expetendis et fugiendis rebus opus.' It was printed in 2 vols. folio, by Aldus, in 1501. It is divided into books, of which there are three on arithmetic; five on music; six on geometry, in which he treats of Euclid, mechanics, optics, &c.; four on astronomy, with observations on the celestial signs as used in medicaments; four on physiology and metaphysics; seven on medicine, with a list of simples; one of problems in physics; four on grammar; three on logic; one on poetry; two on rhetoric; one on moral philosophy; three on domestic and rural economy; one on politics, comprising the pontifical and civil law, the theory of laws in general, and the military art; three on the body, its good and its evil (the first book of the three is on the soul); and one on external things, glory, grandeur, &c. This is a curious work, containing an immense amount of reading, but ill arranged, and adopting many prejudices. The 'Encyclopædia Epistemon, de varii Subjectis,' fol., Basel, 1559. An encyclopædia by J. H. Alstedius, printed at Herborn, in 4to, in 1610; reprinted and enlarged into 4 vols. fol., at Lyon, in 1649. In it he endeavours to prove that the materials and principles of all the arts and sciences are to be found in the Scriptures. Many others followed, among them—by C. Gueinzius, 'Encyclopædia,' 1648, at Halle in Saxony; A. Calovicus, 'Encyclopedias Disciplinarum realium Ideæ,' Lubec, 1651; J. Apazai, 'Magyar Encyclopædiat,' &c., in the Hungarian language, Utrecht, 1653; J. Magnon, 'La Science Universelle, en vers héroique,' fol., Paris, 1663. This last is part of an encylopædia in verse, which the author intended to have completed in ten volumes, each containing 20,000 verses. Fras. Macedo, 'Encyclopediæ in Agonem Literatorum,' fol., 1677. About this period appeared the two works which may be regarded as the forerunner of subsequent general dictionaries of biography, history, and philosophy. The first of these was the 'Grand Dictionnaire Historique et Critique' of Louis Moreri, of which the first edition was published in 1673, in one vol. folio. With many imperfections the work was of great value, and a second edition was speedily required. This Moreri commenced on a larger scale, but he died before the completion of the second volume. Several editions subsequently appeared under various editors; the last being that of Paris, 1759, in 10 vols. fol. The other work to which we referred, though later in point of date, is of far greater literary importance, and indeed has proved a mine of wealth to succeeding writers, though disfigured by some serious errors of opinion; the 'Dictionnaire Historique et Critique,' of Peter Bayle [BAYLE, in BIOG. DIV.], published at Rotterdam, in 4 vols. fol., in 1697. A more bulky work was that of V. Coronelli, 'Bibliotheca Universalis:' in 1709, nine years before the author's death, 18 folio volumes had appeared, which went no farther than *Cavalieri.* It was to have extended to 45 volumes, folio. Between

1732 and 1747, Zedler's 'Grosses vollstandiges Universal Lexicon aller Wissenschaften und Künste,' &c., was published at Leipzig, in 52 vols. folio. In 1751, appeared in Paris the first volume of the celebrated 'Encyclopédie, or Dictionnaire Raisonné des Sciences, des Arts, et des Métiers,' of Diderot and D'Alembert; the 17th and last of the original series was published in 1765, 11 vols. of plates being added to the text, of which the first was published in 1762, the last in 1772. A Supplement was afterwards added, consisting of four vols. of text and one of plates, fol., 1776-7; and there is besides a 'Table Analytique' of the whole work, compiled by M. Mouchon, in 2 vols. folio, Paris and Amsterdam, 1780. Editions of the work have also been printed in France and other parts of the Continent, both in quarto and octavo. [DIDEROT, in BIOG. DIV.] It has been followed in France by another dictionary of arts and sciences of still greater extent, the 'Encyclopédie Méthodique,' begun in 1782 and finished in 1832, in 201 vols. 4to., including 47 vols.. of plates. In this last-mentioned work every art or science is treated of in a separate volume, or series of volumes; so that the whole is in fact merely a collection of dictionaries. Of other foreign encyclopædias, we may notice the German 'Conversations Lexikon' (as it was originally entitled), projected by Mr. Brockhaus, the bookseller of Leipzig, and first published there in 1812. A ninth edition of this work, enlarged to 15 vols. 8vo., was completed in 1848, under its altered title of 'Allgemeine Deutsche Real-Encyclopädie für die gebildeten Stände—Conversations-Lexikon;' and a tenth edition is now (1859) in course of publication. An edition of this work appeared at Leipzig in 1852-58, of which we have already noticed the English translations and appropriations. The French have also issued an 'Encyclopédie des Gens de Monde,' in 22 vols. 8vo, Paris, 1833-44; an 'Encyclopédie Moderne,' with its Supplement, in 36 vols. 8vo, Paris, 1855-57; a 'Dictionnaire de la Conversation et de la Lecture' (edited by W. Duckett), in 68 vols., Paris, 1839-51; of which a new edition, commenced in 1851, is still in progress; and a 'Conversations Lexicon,' founded on the German, now in progress, in 8vo, Paris. There is also now in course of publication the great work conducted by Professors Ersch and Gruber [ERSCH, in BIOG. DIV.], entitled 'Allgemeine Encyclopädie der Wissenschaften und Künste,' which began to be published at Leipzig, in 1818, and of which 122 vols. 4to, have already appeared; namely, the portion from A to Gihom, in 66 vols.; that from H to Junius, in 31 vols; and that from O to Phyxios, in 25 vols. There are other German Cyclopædias; among the most noticeable are Meyer's 'Grosse Conversations Lexikon für die gebildeten Stände,' in 38 vols. royal 8vo, Hildburghausen, 1840-52, with a Supplement in 6 vols., 1853-55, and 8 vols. of plates, consisting of portraits, views, maps, charts, &c.; Pierer's 'Universal Lexikon der Gegenwart und Vergangenheit, oder neuestes encyclopädisches Wörterbuch der Wissenschaften, Künste, und Gewerbe,' third edition, in 34 vols. 8vo., Altenburg, 1840-46. 'Deutsche Enclycopädie; oder, Allgemeines Real-Wörterbuch aller Künste und Wissenschaften.' Von einer Gesellschaft Gelehrten (only carried to letter K), 23 vols. 4to, Frankf. am Mayn, 1778-1807; 'Oesterreichische National-Encyklopädie . . . . vorzüglich der neuern und neuesten Zeit,' 6 vols. 8vo, Wien, 1835-37; being part of a series with 'Oesterreichisches naturhistorisches Bilder-Conversations-Lexikon,' 9 vols. 8vo, Wien, 1835-39; 'Conversations-Lexikon der neuesten Litteratur-Volker und Staatengeschichte,' 2 vols., Leipz. 1841-45: and Herzog's 'Encyclopädie für Protestantische Theologie und Kirche,' to which many eminent German divines have contributed, in 10 vols. 8vo, 1853-9. A translation of a portion of this has also heen published in America. In Spanish, there was commenced in 1842 an 'Enciclopedia Española,' in 8vo., published at Madrid, which is still in progress. At Turin, a 'Nuova enciclopedia popolare Italiana,' begun in 4to., in 1856, is also in progress; as is likewise the 'Svenskt Konversations-Lexikon,' in 4 vols. 8vo., Stockholm, 1845-51.

Some account of the encyclopædias in various languages, but neither very clearly nor very accurately drawn up, and mixed with a great deal of superfluous and useless matter, may be found in a little book called 'Nouveau Système Bibliographique mis en usage pour la connaissance des Encyclopédies,' &c., 12mo., Paris, 1821.

DICYANUM. [MELLON.]

DIDYMIUM (Di) is a metal recently discovered in cerite. Cerite eventually yields, by treatment with sulphuric acid, large red crystals, which are sulphate of didymium: when potash is added to a solution of this salt, hydrated oxide of didymium is precipitated; it has a bluish violet colour, and during washing it absorbs carbonic acid from the air, and when dried it consists mostly of carbonate of didymium and is of a light reddish violet colour; by exposure to a red heat the carbonic acid is expelled, and the oxide is obtained in small lumps of a brown or blackish colour; the powder is light brown: if this oxide be exposed to a white heat it assumes a dirty grayish green colour. It has no alkaline reaction, and is dissolved pretty readily even by dilute acids, which yield salts of an amethystine red colour; the latter are not precipitated by sulphide of ammonium unless heated; the oxide is insoluble in carbonate of ammonia.

Before the blowpipe, the oxide mixed with microcosmic salt becomes amethystine red with a tint of violet; when heated with carbonate of soda on platinum foil, it melts into a grayish white mass. It does not appear to have been reduced to the metallic state.

DIELECTRIC. A term applied to a substance through or across which the electric force is acting. [ELECTRICITY.]

DIE-SINKING. In the preparation of coined money and of medals, the most important feature is the engraving of the die which is to form the stamp. The piece of steel is prepared with the utmost care, and is brought to a soft state when about to be submitted to the hands of the engraver. If the die or stamp be for a medal such as those which have been executed at the Mint by Pistrucci and Wyon, and of which the relief is great, the metal requires to be cut away to a greater depth than in the dies intended for the coining of money, such as shillings, &c. By very minute touches, and by the aid of small, fine, hardened steel tools, the engraver cuts away the steel until he has produced, in cavity or "intaglio," an exact reverse of the design for the medal or coin. The steel, in a soft state while being engraved, requires hardening before being applied to use. The face of the die is covered with a protecting layer of pounded charcoal mixed with oil, and the die is then placed face downwards in a crucible, where it is surrounded with pounded charcoal; after being heated to a cherry-red temperature, it is taken out by means of tongs, and plunged into cold water, the sudden action of which renders the steel extremely hard. When further prepared, so as to be rendered more durable, it obtains the name of the *matrix*, and might be used in that state to stamp coins or medals; but as such a matrix is very costly, and might be spoiled by fracture, arrangements are made for producing multiplied copies of it. A small block of soft steel is, by immense pressure, made to receive an impress, *in relief*, from this matrix; and from this second piece, which obtains the name of the *puncheon*, after being hardened and re-touched by the graver, *dies* or duplications of the original matrix are produced. These dies, when intended for coinage, are intrusted to the Clerk of the Irons at the Mint, whose duty it is to superintend the die-press rooms, the purchasing and forging of the steel, and the engraving and hardening of the dies; to receive and transmit all orders respecting the dies; to be present whenever the die-press is used for multiplying the dies; and to exercise general control over all matters relating to them.

In the use of dies by means of the stamping-press, the number of blows required to transfer the device to a blank piece of metal depends upon the depth of the intaglio. Professor Brande states, that in a medal executed by Mr. Wyon, for the Royal Naval College, there was a representation of the head of William IV., in such bold relief as to require thirty blows of a very powerful press to complete the impression; and that it was necessary, on account of the hardening produced by the pressure, to anneal each medal after every third blow; so that every medal was placed in the furnace ten times during the process of stamping. In another instance (a large medal struck by Boulton), some of the copies are said to have received three hundred blows each, and to have required heating and annealing after each blow.

A remarkable method is sometimes adopted of producing medals from a die by means of stamping, but upon metal which is in a semi-liquid instead of a cold and solid state: the method is called *en cliché*, and has been much practised in France. The metal of which these medals are formed is one of the various kinds of fusible metal, such as will melt at a low temperature. Type-metal, consisting of five parts of lead to one of antimony, will answer for the purpose, but it is deemed better when a little more lead is added to it; many different alloys of tin, lead, bismuth, and antimony, however, will suffice. The die to be employed is fixed face downward at the lower end of a stamper, which works within a box or case to prevent the liquid metal from splashing about; at the bottom of the box is a cast-iron plate, on which is placed a small paper tray. The alloy is melted, and allowed to cool down to a pasty state; a little of it is placed in the paper tray; the box is closed on all sides, and the stamper is allowed to fall on the alloy, by which a medallion is produced from the die, rough at the edges, and with an impress only on one side. The contact of the cold die solidifies the alloy, and produces a clear and tolerably sharp impression. The medallions so produced are trimmed at the edge by a lathe, and rendered smooth at the back; sometimes two are fixed together back to back, to form a perfect medallion; and sometimes they are mounted in cases, with only one side visible—the surface being bronzed with metallic sulphates. In some instances, instead of cliché medals being produced from engraved dies, cliché moulds are produced from models made of plaster, wood, sulphur, clay, wax, or metal: thus, the Italian figure-casters often make casts from medallions and small bassi-rilievi by means of moulds which have been made *en cliché* from models.

Die-sinking is regarded in the above paragraphs chiefly in its connection with the fine arts; but the slightest glance at the industry of Birmingham, and other seats of the metal manufacture, will show how largely die-sinking is necessary for the operations carried on in the stamping-works. In this point of view, a suggestion worthy of notice was made by Mr. Kidd, of Sheffield, and communicated to the 'Mechanics' Magazine' in 1858. It was to the effect that die-sinking might possibly be accomplished by the aid of electro-metallurgy. "Take, as an example," he said, "a pair of dies for casting metal buttons. Let a model in wax be made, with the face of the button standing out in relief on a flat surface of (say) an inch all round its edge. The face of the model must now have a conducting surface imparted to it, either by black-lead or by the phosphorus and gold solution. Then place it in an electrotyping apparatus for receiving a coating of iron. When this coating is of tolerable thickness (say one-sixteenth of an inch), a piece of iron, of the same diameter as the model, and perhaps half an inch thick, is to be covered with wax on the back and circumference, and placed with the face (perfectly free from grease or dust) opposite to the model, and touching the iron on its surface. The deposited metal [of the galvanic trough] will now be thrown down between the two; and if the strength of the battery be carefully regulated, they will be united into one whole piece. All the wax may now be removed, and the edges trimmed with a file. We shall thus have one of the dies in which to cast the button; the other may be made in the same manner. This method is applicable to the making of dies for casting all kinds of ornaments in soft metal, such as teapot-knobs, handles and feet of cruet-frames; also dies for stamping soft materials, as leather shot-pouches, bookbinders' work, &c. As the temper of the metal deposited depends entirely upon the intensity of the battery-current, I have no doubt that, if this were carefully regulated, dies might be made fit for stamping Britannia metal or copper. The great recommendation of the process is its extreme cheapness."

DI'ESIS, in ancient music (*δίεσις, division*). The Greeks divided a tone into a major and minor semitone; the greater was called an apotome [APOTOME], the lesser a limma, or Diesis: to the difference between the two the name of comma [COMMA] was given. But it must here, once for all, be observed, that the Greek writers, if we really enter into their meaning, differ much in their definitions of musical inetrvals, and that the moderns are no less at variance in their interpretation of many ancient terms of the art.

DIETHYLAMINE. [ORGANIC BASES.]

DIETHYLANCYLAMINE. [ORGANIC BASES.]

DIETHYLANILINE. Synonymous with *diethylphenylamine*. [ANILINE.]

DIETHYLCHLORANILINE ($N(C_{12}H_4Cl(C_4H_5)_2)$. A derivative from chloraniline. [ANILINE.]

DIETHYLCONINE ($C_{24}H_{23}N$). An organic base formed by replacing two equivalents of hydrogen in conine by two of ethyl. [CONINE.]

DIETHYL-CYANAMIDE $\left(N\left\{\begin{matrix}C_4H_5\\ C_4H_6\\ Cy\end{matrix}\right.\right)$. An organic body consisting of cyanamide in which two equivalents of hydrogen are replaced by two of the radical ethyl. [CYANAMIDE.]

DIETHYLCYANURIC ACID ($C_{14}H_{10}N_3O_5, HO$). A crystalline acid, obtained as a secondary product in the preparation of cyanuric ether. Fused with potash it yields ethylamine.

DIETHYLINE ($C_{14}H_{16}O_6$). This organic compound is formed by the juxtaposition of one atom of glycerine with two atoms of alcohol, and the abstraction of four atoms of water.

$$\underbrace{C_6H_8O_6}_{\text{Glycerine.}} + \underbrace{2C_4H_6O_2}_{\text{Alcohol.}} - 4HO = \underbrace{C_{14}H_{16}O_6}_{\text{Diethyline.}}$$

It is prepared by heating a mixture of glycerine, bromide of ethyl, and potash to 212° Fahr. for about 80 hours, then separating the upper layer of resulting liquid from the lower, and distilling the former. That portion of the distillate which passes at 376° Fahr. is pure diethyline. This body is a colourless and transparent liquid, possessing a slight ethereal odour and a specific gravity of ·92. It is but slightly soluble in water. Heated with quicklime it disengages acrolein.

DIETHYLMECONIC ACID. [MECONIC ACID.]

DIETHYLOXAMIDE. [OXAMIDE.]

DIETHYLPHENYLAMINE. [ANILINE.]

DIETHYLPHOSPHORIC ACID. [PHOSPHORIC ACID.]

DIETHYL-TOLUIDINE. [TOLUIDINE.]

DIETHYL-UREA. [UREA.]

DIET. [FOOD.]

DIFFARREATION. [MARRIAGE.]

DIFFERENCE, the excess of one quantity over another. This fundamental meaning of the term is almost lost in the higher parts of mathematics, from the association of it with a methodised theory, derived from the consideration of the differences presented by successive quantities which follow a regular law. It is, therefore, a very wide branch of pure mathematics which must be considered under this term; namely, the method of calculus of differences. And the connection of this subject with the differential calculus (the results of the latter being, in one point of view, particular cases of the former) renders it impossible to treat of the two with that perfect separation which the alphabetical arrangement of a work like the present requires. Following the plan which we have laid down in other articles, we shall here describe the most important results connected with the term in question, referring for information on other matters to the following articles: INTEGRATION, FINITE; GENERATING FUNCTIONS, THEORY OF; EXPONENTS, NOTATION OF; OPERATION; EQUATIONS OF DIFFERENCES; INTERPOLATION.

If we carry the hand along a sheet of paper, laying down points with a pen at various intervals, we get a number of points, through which an infinite number of curves may be made to pass; but, generally speaking, there is one which is more simple than all the rest. If we also assign various numbers, we may conceive them all to be values of some function of a variable x, answering to $x=1$, $x=2$, &c. Thus we may ask the following question: what is that function of x of which 43, 47, 53, 61, 71, 83, &c., are the values, when x is successively made equal to 1, 2, 3, 4, 5, 6, &c.? This problem is indeterminate, with respect to common algebra merely, unless we can ascertain a law by which the series can be continued *ad infinitum*, and which it is allowable to assume; it then becomes determinate with respect to the expressions of common algebra only, but is again indeterminate if we are allowed to assume the transcendental expressions of trigonometry or the integral calculus. Confining ourselves to the expressions of common algebra, we may detect any law which prevails throughout the whole series by taking the difference between each term and the next, and thus forming a new series; and then by repeating this process again and again until the series so formed presents an easily perceptible law. Thus in the preceding case we have

	Given series	43	47	53	61	71	83 ...
Series of	First differences	4	6	8	10	12	
	Second differences	2	2	2	2		

We now see that, irregular as the first series may appear, the successive differences of the successive differences of its terms are always the same, and we may thus extend the series further. Thus we have—

83 97 113 131 151 173, &c.
12 14 16 18 20 22, &c.
2 2 2 2 2 2, &c.

But still this question remains, assuming the preceding law of continuation, and also that we have thus the values of some function of x answering to $x=1$ (namely, 43), $x=2$ (47), &c.: What is the value of the function answering to fractional values of x; for instance, when $x=2\frac{1}{2}$? Considering that $x=2$ gives 97, and $x=3$ gives 113, it might seem at first sight that $x=2\frac{1}{2}$ should give 105. But a moment's consideration will show that this can only be in the series

81 97 113 129, &c.,

and that the irregularity of the progression from term to term will require a law to express it, such as will not allow of uniform progression between the terms. Such are the notions which might be made to suggest themselves, and the difficulties of which find their answers in the mathematical consideration of the subject.

Let any term chosen at pleasure in a series be called a, let the next term be a_1, the next a_2, and so on: that is, a_n means the nth term from a, not reckoning a. The succession of *first differences* (a more convenient way of expressing the *first succession* of differences) is—

$$a_1-a,\ a_2-a_1,\ a_3-a_2,\ a_4-a_3\ \ldots\ldots\ldots$$

The succession of *second differences* (*second succession* of differences) is—

$$\begin{gathered}a_2-a_1-(a_1-a),\text{ or }a_2-2a_1+a\\ a_3-a_2-(a_2-a_1),\text{ or }a_3-2a_2+a_1,\text{ \&c.}\end{gathered}$$

The succession of third differences, similarly derived from the preceding, is—

$$\begin{gathered}a_3-3a_2+3a_1-a,\\ a_4-3a_3+3a_2-a_1,\text{ \&c.}\end{gathered}$$

From which it may be made evident to any one who knows the binomial theorem and the law of its co-efficients, that the first term of the nth succession of differences is—

$$a_n-n\,a_{n-1}+n\,\frac{n-1}{2}\,a_{n-2}-\ \ldots\ldots\ (n+1\text{ terms}).$$

It is usual to denote this by $\Delta^n a$, the letter Δ standing for the operation of taking the difference, the exponent expressing that this operation has been repeated until it has been performed n times, and a being the term of the series used in the first operation. The symbol is called the nth difference of a.

If, then, we write the series and its successions of differences, not using the results of the operation, but their symbols, we have as follows:—

$$\begin{array}{ccccccc}a & a_1 & a_2 & a_3 & a_4 & \ldots\ldots\\ & \Delta a & \Delta a_1 & \Delta a_2 & \Delta a_3 & \ldots\ldots\ldots\\ & & \Delta^2 a & \Delta^2 a_1 & \Delta^2 a_2 & \ldots\ldots\\ & & & \Delta^3 a & \Delta^3 a_1 & \ldots\ldots\\ & & & \text{\&c.} & & \end{array}$$

From which we find that $a_1=a+\Delta a$.

$$\begin{aligned}a_2&=a_1+\Delta a_1=a+\Delta a+(\Delta a+\Delta^2 a)\\ &=a+2\Delta a+\Delta^2 a\\ a_3&=a_1+2\Delta a_1+\Delta^2 a_1=a+\Delta a\\ &\qquad+2\,(\Delta a+\Delta^2 a)\\ &\qquad+\Delta^2 a+\Delta^3 a\\ \text{or, }a_3&=a+3\Delta a+3a\,\Delta^2 a+\Delta^3 a.\end{aligned}$$

Proceeding in this manner, and by the assistance of the binomial theorem as before, we find that—

$$a_n=a+n\,\Delta a+n\,\frac{n-1}{2}\,\Delta^2 a+\ \ldots\ldots\ (n+1\text{ terms}).$$

These two theorems are the fundamental parts of the whole theory of differences; and our limits will not allow us to go further into the subject. We shall only observe, that it is most desirable that this very elementary branch of pure mathematics should be taught as a part of common algebra, or at least with the first rudiments of the differential calculus. The almost universal practice of deferring this subject until the student is master of the integral calculus, is entirely subversive of all natural order, and is perhaps one of the reasons why the differential calculus is proverbially difficult. Various developments and applications are to be found in every work on the subject.

The term difference is Continental; the older English term was *increment.*

DIFFERENCE, ASCENSIONAL. [Ascension.]

DIFFERENCE, EQUATIONS OF. [Equations of Differences.]

DIFFERENTIAL CALCULUS, the name given by Leibnitz to the science which was digested nearly about the same time by himself and Newton, independently of each other [Fluxions; Commercium Epistolicum], and which has of late years almost exclusively prevailed in this country, to the exclusion of the name, notation, and (so far as they differ) methods of Newton's fluxions.

It is impossible, in the smallest degree, to exhibit the present state and uses of a science into which all others merge as the student approaches the higher applications of mathematics. The article Differential Coefficient will, so far as it goes, give some idea of the nature of its first step; but the following remarks must be considered as intended for the student who has made some progress in a modern elementary work.

The history of the differential calculus, at its first rise, is so connected with that of the Newtonian Fluxions, in consequence of the celebrated dispute as to the right of invention, that we have thought it best to refer the whole point to the last-named article. On the history of the science since the time of Newton, there is no work from which we can trace out a connected account of the various steps by which the present system has been formed. In fact, most of the new investigations have been made with reference to some particular points of physical science. It would be very difficult to write the history of this calculus without entering at the same time into that of mechanics, optics, astronomy, &c. &c., and of every subject to which it has ever been applied. An attempt at the former without the latter would be an account of the progress of language without mention of literature, oratory, or the drama.

In the meanwhile, seeing that notions as to the most proper and useful basis on which to build this science are far from being fixed, the most advantageous course which we can here adopt is to give a short account of the various systems which have been proposed, referring to such articles and treatises as will enable the student to obtain further information. These different systems all produce the same results, expressed in very similar manners; there is no question between them as to the truth or falsehood of any one deduction, and a practised intellect can always see how the principles of any one, *assumed as granted*, may be made to furnish demonstrations of those of any other. It is therefore, with some exception, a psychological rather than a mathematical difference which agitates (or rather which did agitate) the mathematical world. We do not mean to say that opinions are now agreed; but it seems that the question is left open, it being admitted that the manner in which a student arrives at his knowledge of the subject in the first instance is not of the greatest importance, provided that, when it has been obtained, he give his attention to the comparison of the various methods by which he might have attained the same end.

The precursors of Newton and Leibnitz, namely, Archimedes, Cavalieri, Wallis, Barrow, Fermat, Roberval, and others, touched so near upon the differential calculus, that it is obvious any one of them might have taken the place of either of the first, if he had possessed more powerful means of algebraical development. After Vieta, Descartes, Wallis, and Newton (considered only as the discoverer of the binomial theorem), the step to a formal calculus was comparatively small. The essential part of the difficulty had been removed, and by much the greater part of the distance between Archimedes and Leibnitz had been gained. This point once attained, *methods* sprung up with rapidity, and in little more than a century we find the introduction of the various schemes which it will be necessary to mention, namely—Leibnitz's method of infinitesimals; Newton's method of prime and ultimate ratios; Newton's method of fluxions; Landen's method of vanishing fractions, or residual analysis; D'Alembert's method of limits; Lagrange's method of derivation. In saying, however, that the step to a formal calculus made by Newton and Leibnitz was comparatively small, we only mean that it appears small to those who have been taught how to make it. For one man who can make this *last simple step*, which puts the many into the position formerly held by the few, there are scores who can *all but* do it, and who have claims put in for them when the thing is done, but not before. A proverb, it is said, is the wisdom of many, but the wit of one; a great method in science is always within the perception of many, before it is within the grasp of one.

Many other forms have been proposed, which either coincide in principle with one or other of the preceding, or are without any independent claim to notice. Several of the preceding, indeed, are more distinguished from each other by historical notoriety than by essential difference of character. If we distinguish carefully between the first principles of a method and the manner in which those principles are applied to algebra, it would not be any great stretch of assertion to contend that all the methods except the last are different ways of expressing the same fundamental ideas; and that the last (Lagrange's) is a proof that, so long as the preceding methods employed the usual amount of algebraical assumption in the establishment of the connection between themselves and algebra, that same quantity of assumption would have been sufficient for the basis of a purely algebraical science, equivalent to the differential calculus.

The method of Leibnitz assumes that quantities are made up of infinite numbers of infinitely small parts. [Infinitesimal Calculus; Infinite.] It is a sort of atomic theory of pure magnitude, which is most obviously either false or obscure; for so far as infinitely small quantities can be definitely explained as objective realities, it is obvious that there are no such things; and any obscurity left in their definition extends itself throughout the whole science. But the falsehood of the supposition is not absolute; for though magnitudes cannot be distinctly laid down to be composed of an *infinite* number of *infinitely small* parts, yet any magnitude can be divided into a number of parts *greater than any we may happen to name*, each of which parts shall be *less than any magnitude we may happen to name.* Thus it is perfectly obvious that a foot may be divided into parts more than a million in number, each of which shall be less than the hundred millionth part of an inch. If we may use such a phrase, the falsehood of the assertion may be made of as small an intensity as we please, and the consequence is, that its results turn out absolutely correct. All the difficulties of the science are concentrated into one single assertion; and when this assertion is once fairly understood and received in a correct sense, all that follows is more easily understood and remembered, and far more easily applied, than the results of any other method. Whichever of the systems a student pursues, it is our decided opinion that he should accustom himself to translate every result into the language of the infinitesimal calculus, and endeavour to demonstrate it by the methods of the same. It is usual to give a chapter on this method in elementary works; in addition to which we should strongly recommend to the student of principles, Carnot, 'Réflexions sur la Metaphysique du Calcul Infinitesimal,' last edition, Paris, 1839. But we must be understood not to recommend the peculiar method of explaining the difficulties of infinitesimals adopted in this work, but only the manner of stating the points of difficulty, and the comparison of the different systems.

The system of Newton, known by the name of prime and ultimate ratios, was set forth in the first section of the Principia, and is the method pursued throughout that work. It is in reality a method of limits, exhibited in a form which allows of a more ready application to geometry than to algebra, and accordingly it is abandoned by Newton himself in the method of fluxions. Instead of considering and comparing simultaneous increments of infinitely small magnitude, the ratios of small but finite increments are taken; and not these exactly, but the limits towards which they approach when the increments are diminished, which are called *ultimate* ratios, or *nascent* ratios, according as the increments are supposed to be *in the act* of growing from or diminishing towards nothing. The expression of Newton will justify us in using the three words in italics: "Objectio est, quod quantitatum evanescentium nulla sit ultima proportio: quippe quæ, antequam evanuerunt, non est ultima; ubi evanuerunt, nulla est. . . . . Similiter per ultimam rationem quantitatum evanescentium, intellegendam esse rationem quantitatum, *non antequam evanescunt, non postea, sed quâcum evanescunt.* Pariter et ratio prima nascentium est ratio quâcum nascuntur?" The student must seek for the account of this method in the first section of the Principia already cited, and in the article Ratios, Prime and Ultimate. It may be observed that in illustrating the preceding answer, Newton appeals to the fundamental considerations on which his other method (if it be really another method) is founded, to which we now come.

The method of fluxions was also given by Newton, and with a peculiar notation, which maintained its ground in this country until about the year 1816. [Fluxions.] It will be seen in the articles Direction, Velocity, Force, &c., that there are many fundamental ideas, connected with sensible objects, which lead to a practical differential calculus, and might have happened to have been the means of suggesting a strict and mathematical theory. Newton adopted one of these, that of velocity, of which it may be said that its assumption as an answer to objections is an evasion of all the metaphysical difficulties of the subject. Since the proportions of all quantities may be represented by those of straight lines, the nature of the comparative changes which take place in continuously increasing or decreasing quantities may be referred to the velocities with which the terminal points of straight lines change their places. Velocity once clearly defined, in cases where it is variable, there is no further difficulty; but unfortunately a distinct conception of the measure of velocity is precisely equivalent to finding a meaning for the differential or fluxional coefficient independently of it. The theory of fluxions is best exhibited in the work of Maclaurin, 'Treatise on Fluxions,' 2 vols. 4to., Edinburgh, 1742, which, for rigorous and consistent application of its own principles, has, in our opinion, never been surpassed. It has the advantage of having been written in answer to acute objections of principle [Berkeley], and is *the* work on fluxions.

The method of limits of D'Alembert, which is now more frequently used than any other, was considered by the author himself as an explanation of Newton's prime and ultimate ratios. It is usual to attribute the exposition of this method to D'Alembert (and, considered as an actual application of limits, correctly), though several, previously to him, had made special applications of the principle. The articles in the Encyclopédie must be considered as the *pièces justificatives*. The following article, Differential Coefficient, will explain this method, which contains the point in which the principles of all the preceding unite, and which must more or less be in all. See also the article Limit.

The two remaining methods (those of Landen and Lagrange) are attempts to establish the science upon purely algebraical principles. Previously to entering upon them, we must remark that none of the preceding theorists attempted to make his system furnish any additional security to the methods of the algebra already in use. Such as it was, correct or incorrect, clear or obscure, no one gave a moment's consideration to the fact that algebra already contained difficulties of precisely the same character as those which were matter of dispute in the differential calculus. Taking it for granted that algebra in every part stood already upon as firm a basis as the differential calculus could ever on any supposition be expected to do, it was a matter of some interest to make the latter a pure extension of the former.

The residual analysis of Landen is a technically algebraical exhibition of the theory of prime and ultimate ratios. The tract in which it was promulgated, 'the Residual Analysis, a new branch of the Algebraic Art,' &c., appeared in 1764. When it is considered that this new branch of the algebraic art was only old fluxions in a different dress, the title may excite surprise, if we remember how well Landen deserved his reputation. But it must be remembered that all the discussion of which this article is meant to elucidate the history, arose from a tendency to consider two methods as *mathematically* different, which were not the same in the method of enunciating their first principles. A something between Landen and D'Alembert, as to principle, published in 1748, was called the 'Doctrine of Ultimators, containing a new Acquisition, &c., or a Discovery of the true and genuine Foundation of what has hitherto mistakenly prevailed under the improper names of Fluxions and the Differential Calculus.' The difference between Landen and Newton will appear in the article Fractions, Vanishing, and in the instances which we shall presently give. It is the limit of D'Alembert supposed to be *attained*, instead of being a *terminus* which can be attained as nearly as we please. A little difference of algebraical suppositions makes a fallacious difference of form; and though the residual analysis draws less upon the disputable part of algebra than the method of Lagrange, the sole reason of this is that the former does not go so far into the subject as the latter.

The method of Lagrange, first given in the public lectures at the École Normale, and afterwards published separately under the title of *Théorie des Fonctions*, is a deduction of the whole science from Taylor's Theorem, which being absolutely granted, undoubtedly all the rest may be made to follow. If $\phi\,(x+h)$ can be always expanded in a form of which the two first terms are $\phi\,x+\phi'x.\,h$, and if $\phi'\,(x+h)$ be related in the same manner to $\phi'x+\phi''x.\,h$, and $\phi''(x+h)$ to $\phi''x+\phi'''x.\,h$, and so on, it can be made to follow that

$$\phi\,(x+h)=\phi x+\phi'x.\,h+\phi''x.\frac{h^2}{2}+\phi'''x.\frac{h^3}{2.3}+\&c.$$

upon principles as sound as those of algebra in the hands of Maclaurin, or Euler, or Clairaut, as elementary writers. It is our opinion that Lagrange has not been correctly understood, nor fairly dealt with, by those who have compared his theory of functions with the other methods. Undoubtedly any one who should maintain the unqualified admissibility of Lagrange's work must assert both the major and minor of the following syllogism.

Algebraical expansion (*théories des suites* is Lagrange's phrase) as generally received in 1790, was founded on sound principles: the *théorie des fonctions* is a logical and incontestable result of such algebra; therefore, &c.

All the attacks upon Lagrange have denied the major of this syllogism, whereas it appears to us that he never intended to assert more than the minor. Perceiving that the mathematical world was in the habit of calling in the aid of limits or infinitesimals, to help *a certain algebra* in deducing certain conclusions, he showed them how that very algebra, good or bad, was competent to the deduction of the same conclusions without either limits or infinitesimals; and he was correct. Notwithstanding anything in the work in question, Lagrange might have admitted all that we shall find it necessary to say against his system, absolutely considered, in the article Functions, Theory of.

A new question has arisen of late years, namely, whether the theory of limits be not absolutely necessary to the rigorous development of common algebraical forms, and whether this same theory of limits may not be applied to the establishment of the differential calculus, independently of any expansion. A tract of M. Ampère (as we believe), entitled 'Précis du Calcul Differentiel,' &c., is the earliest writing we are acquainted with in which this is attempted to be done. Mr. de Morgan's treatise on the subject, published by the Society for the Diffusion of Useful Knowledge, professes to have the same end in view. The works of M. Cauchy have much in them by which this object is promoted, but expansion is avowedly introduced.

We shall now state two propositions, one geometrical, the other algebraical, in the words of the several systems.

1. *Infinitesimals.*—An infinitely small arc of a circle is equal to its chord.

Prime and Ultimate Ratios.—If an arc of a circle diminish, the ultimate ratio which it bears to its chord is one of equality; or if it begin to increase from nothing, the prime or nascent ratio of the arc and chord is that of equality. Or the arc is *ultimately* equal to its chord.

Fluxions.—If an arc increase from nothing with a uniform velocity, the velocity with which the chord increases is, at the first moment, equal to that of the arc.

Limits.—If the arc of a circle (and therefore its chord) diminish without limit, the limit of the ratio of the arc to the chord is one of equality.

Residual Analysis.—When the arc of a circle $= 0\ \frac{\text{arc}}{\text{chord}}=\frac{0}{0}=1$, which is ascertained by clearing the numerator and denominator of a factor which vanishes when arc $=0$.

Theory of Functions.—When the arc is expanded in the following series,

$$\text{Arc} = \text{A} \times \text{chord} + \text{B} \times (\text{chord})^2 + \&\text{c.}$$

then $\text{A} = 1$.

2. *Infinitesimals.*—If an infinitely small increment dx be given to x, then x^3 receives the infinitely small increment $3x^2dx$.

Prime and ultimate Ratios.—The ratio which any increment given to x bears to the consequent increment of x^3 is ultimately that of 1 to $3\,x^2$.

Fluxions.—If x be a line which increases with a velocity $\dot{x}$, then x^3 increases with the velocity $3\,x^2\dot{x}$.

Limits.—The limit of the ratio obtained by dividing an increment of x^3 by the increment of x which produced it, on the supposition that the latter increment diminishes without limit, is $3\,x^2$.

Residual Analysis—Since

$$\frac{y^3-x^3}{y-x}=x^2+xy+y^2$$

it follows that when $y=x$, $\frac{x^3-x^3}{x-x}=3\,x^2$.

Theory of Functions.—If $(x+h)^3$ be expanded in a series of powers of h, the coefficient of the first power of h is $3x^2$.

DIFFERENTIAL COEFFICIENT. The expressions to which this term is applied are of a degree of importance in the science to which they belong, as great as that of the letters of the alphabet in writing. Without entering into the method of using them, which would be in effect to write a treatise on the differential calculus, we shall make some remarks on the manner of defining and understanding the term.

When two magnitudes are so related that either being given the other is also given, it follows that any change being made in the one, the consequent change in the value of the other can be found, and the two changes can be compared as to magnitude. By this means a rough notion can be formed as to the effect which a change of value in one produces in the other. In such articles as Curvature, Direction, Velocity, Force, &c., it is sufficiently shown that this rough notion, obtained by making a sensible change in one magnitude and comparing it with that produced in another, though sufficient for practical purposes, does not afford any exact and mathematical measure of the thing sought for. In each of the articles cited, it is found necessary to diminish the change originally supposed without limit, and it is not the actual ratio of two changes which we have to consider, but the limit to which that ratio approximates as the changes are diminished without limit. We must distinctly refer the student to sensible objects for an illustration of the cause why it is convenient, and even necessary, to have recourse to the *limit of a ratio*. [See also Limit, Ratios (Prime and Ultimate), and various articles cited in Differential Calculus.]

Let ϕx be a function of x, called y, which when x is changed into $x+h$, becomes $y+k$, so that

$$k = \phi\,(x+h) - \phi x.$$

Divide k by h, ascertain the limit towards which this quotient approximates when h is diminished without limit, and that limit is what is called the differential coefficient of y with respect to x. For instance, let $y = x^2 + x$; then

$$\begin{aligned} k &= (x+h)^2 + (x+h) - (x^2+x) \\ &= 2\,xh + h^2 + h; \end{aligned}$$

and k divided by h gives $2x + h + 1$, which, when h is diminished without limit, has for the limit of its decrease, $2x + 1$, which is therefore the differential coefficient of $x^2 + x$ with respect to x.

The term *differential coefficient* arises thus. The method of Leibnits [Infinitesimal Calculus] proceeds as follows: Imagine x in the preceding expression to be increased by an *infinitely small quantity* (see article just cited for remarks on this phrase) which call dx, the *differential* of x. Then the resulting differential of y is

$$\begin{aligned} dy &= (x + dx)^2 + (x + dx) - (x^2 + x) \\ &= (2x + 1)\, dx + (dx)^2 \end{aligned}$$

Now $(dx)^2$ is rejected as being an infinitely small part of the preceding term, so that $(2x + 1)\, dx$ is the *differential* of $x^2 + x$. The expression $2x + 1$ (which is our preceding result) is here the *coefficient* of the *differential* dx, and when a less objectionable method of obtaining it came into use, still retained the name of differential coefficient. It were* exceedingly to be wished that some shorter term could be agreed on for the expression of a result which is so often required to be named.

In the method of Leibnitz the differential coefficient is actually dy divided by dx, and it is still expressed by $\frac{dy}{dx}$ in the more modern methods. But this notation must now be supposed to be obtained as follows: Let the change of x into $x + \Delta x$ be accompanied by that of y into $y + \Delta y$; then $\frac{\Delta y}{\Delta x}$ expresses the algebraical ratio of the change of y to the change of x. In making the convention that $\frac{dy}{dx}$ is to stand for the limit of $\frac{\Delta y}{\Delta x}$, obtained from the supposition that Δx diminishes without limit, we consider the first symbol, not as that of an algebraical fraction, but as one whose *whole* has a meaning, the *parts* having none. This is the case with all *simple* symbols, as distinguished from *compound* symbols: thus in the figure V, standing for five, the two sides of the letter have no independent meaning; while in 4 + 7, each of the three symbols, 4, +, and 7, has meaning contributing to that of the whole, and at the same time independent of it. Thus though we consider $\frac{dy}{dx}$ as pointing out that it is y which has been differentiated, and with respect to x, we do not, in this symbol, assign to dy and dx any independent share of meaning.

The advantage of the notation in question is the connection which it preserves between the practical use of the method of Leibnitz, and the theoretical accuracy of that of limits. For instance, it is strictly true, according to our conventions, that

$$\text{when } y = x^2 + x,\ \frac{dy}{dx} = 2x + 1.$$

but, giving dy and dx separate meaning, it is *not* true that $dy = (2x + 1)\, dx$. Yet the latter equation, though never true, is of this kind, that it may be made as near to truth as we please, if dx may be made as small as we please. For the reason why it cannot therefore be said to be true in the case where $dx = 0$, see FRACTIONS, VANISHING.

The differential coefficient of a differential coefficient is called the *second* differential coefficient; a repetition of the process gives the third differential coefficient: and so on. These, if the original method of notation were proceeded with, should be represented by

$$\frac{dy}{dx} \qquad \frac{d\left(\frac{dy}{dx}\right)}{dx} \qquad \frac{d\left(\frac{d\left(\frac{dy}{dx}\right)}{dx}\right)}{dx}, \text{ \&c.}$$

but a more convenient notation is derived as follows: Let the substitution of $x + \Delta x$ for x take place any number of times in succession, giving

$$\phi(x)\ ,\ \phi(x + \Delta x)\ ,\ \phi(x + 2\Delta x)\ ,\ \phi(x + 3\Delta x), \text{ \&c.}$$

Form the successive differences of the first term [DIFFERENCE] ϕx or y: then the following theorem can be proved. The nth difference of y, or $\Delta^n y$, divided by the nth power of Δx, or $(\Delta x)^n$, is an expression of which the limit, made by diminishing Δx without limit, gives the same result as arises from differentiating y, n times in succession. We may therefore (subject to the remarks already made on the *first* coefficient) represent the limit of $\frac{\Delta^n y}{(\Delta x)^n}$ by $\frac{d^n y}{(dx)^n}$, so that the function y and its successive differential coefficients are denoted as follows:—

$$y\ ,\ \frac{dy}{dx}\ ,\ \frac{d^2 y}{dx^2}\ ,\ \frac{d^3 y}{dx^3}\ ,\ \frac{d^4 y}{dx^4}\ , \text{ \&c.}$$

It is usual to omit the brackets in the denominators.

DIFFERENTIAL EQUATIONS. [EQUATIONS, DIFFERENTIAL.]

DIFFERENTIAL THERMOMETER. [THERMOMETER, DIFFERENTIAL.]

DIFFRACTION OF LIGHT. The peculiar modifications which light undergoes when it passes by the edge of an opaque body are classed as phenomena of the *diffraction* or *inflexion* of light.

When a pencil of solar light is admitted into a darkened room through a very small hole in a card, or is collected in a point by means of a convex lens of short focus, and then diverges from that point, if a small opaque plate of any outline be interposed in the course of the ray, the shadow of this object received on a parallel screen behind will be encompassed by a series of coloured bands or fringes of a similar outline with the body, except at its angular points; the order of the colours in each fringe, reckoning from the outside towards the shadow, or inside, is, as in the prismatic spectrum, from red to blue, but the intermediate colours are less distinctly isolated, partaking of a mixture of the extreme tints.

The actual shadow, or dark space within the innermost fringe, is also larger than the geometrical shadow which would have been cast if the rays had passed exactly by the edge of the body in straight lines and been received on the same screen, and the illumination instead of being cut off sharply, fades continuously into the darkness of the shadow, extending indeed to a small amount even within the geometrical shadow. The space by which the actual shadow surpasses the geometrical in breadth, is independent of the form or the matter of the interposed body, and likewise, except in the case of a very slender body, of its linear dimensions. The dilatation of the shadow will therefore be most striking in the case of narrow bodies such as pins, hairs, &c.

When the interposed body is very narrow but of sensible width, streaks alternately brighter and darker will be found *within the shadow*, and a white line along the middle, when the body is of a long and slender rectangular form.

All these phenomena are seen more easily and with greater brilliancy if the light, instead of being received on a screen, be admitted directly into the eye armed with a lens or eye-piece.

If the incident light were homogeneous, such as pure red, blue, &c., as found in the spectrum, the colour of the fringes would of course be the same as that of the incident light, and the fringes would consist of simple alternations of light and shade. It is found that the scale of the fringes varies with the colour, the fringes being broadest for the least refrangible colours. Hence when the incident light is white the fringes are variously coloured, in consequence of the encroachment of the bright and dark fringes belonging to the various simple coloured lights of which, as we know, white light is compounded.

Sir I. Newton in his optics relates several modes in which he varied the experiments on the inflexion of light; and, in his queries, he suggests an explanation that light may be subject to the action of forces sensible only at very small distances from the surfaces of bodies; that under their influence the rays in their course near the edge of the body, instead of passing straightforward, describe very sinuous paths, with many contrary flexures, and thus they are found some turned inwards towards the shadow, others outwards, forming coloured bands; the curve surface, which is the locus of the intersections of all those diffracted rays, forming the envelope of the visible shadow. Little advance has been made beyond Newton's conjectures towards explaining, according to this doctrine, the curious phenomena of diffraction; and the explanation, incomplete as it is, has been shown by Fresnel to be subject to serious difficulties.

Very different has been the result with the theory which makes light to consist of undulations. This theory was first applied to the explanation of the phenomena by Dr. Young, who employed the principle of *interference*, the discovery of which we owe to him, and which he so successfully applied to the explanation of the colours of thin plates. The bending of light around an opaque body was assimilated to the bending of waves around an obstacle, and the internal fringes in the shadow of a narrow body to the *interference* of the light so bent round the opposite edges. That these fringes are incontestably produced by interference, he proved by cutting off the light passing either edge by means of an opaque screen placed either before or behind the narrow body, when the internal fringes immediately disappeared. The external fringes were attributed to the interference of the direct light with the light reflected from the edge of the diffracting body ('Phil. Trans.' for 1802, p. 12). Several of the observed laws of the phenomena were shown to be explicable on this hypothesis.

This explanation was in the first instance adopted by Fresnel; but in pursuing his researches he met with phenomena which opened his eyes to the insufficiency of the explanation, and at last led him to perceive that the various observed appearances flowed naturally from two grand principles—the principle of interference, and the principle of Huygens—which themselves are but particular applications of the general dynamical principle of the co-existence of small motions. In his celebrated memoir on diffraction ('Mém. de l'Académie,' 1821, tom. v. p. 339), he has followed out this theory into its mathematical details, and compared the results with observations both qualitatively and quantitatively, by a series of most careful measures; and the agreement is complete. The theory furnishes not a single disposable constant whereby a seeming accordance between theory and experiment might have been brought about, for the length of a wave of light, the only unknown constant involved, admits of being determined independently of diffraction by the interference of two streams of *regularly* reflected or refracted light.

About the same time, and independently, Fraunhofer was engaged in a series of researches on diffraction of a somewhat different class, namely, those produced when a luminous point or slit is viewed in focus through a telescope, and the object-glass is covered by a screen pierced with one or more apertures. The reader may easily observe phenomena of this kind by viewing a bright point, such as the image of the sun in the bulb of a thermometer, and covering the eye with a piece of fine gauze, or of tin foil or black paper pierced with one, two, or three minute needle-holes, or apertures of other shape. The most remarkable instance observed by Fraunhofer was that of a fine grating through which was viewed a slit of light parallel to the lines of the grating. In this case spectra were formed so pure as to exhibit the fixed lines; and in this way Fraunhofer has measured with the most extraordinary accuracy the wave lengths corresponding to the fixed lines which he denotes by C, D, E, F, G, H. (Gilbert's 'Annalen.' Bd. 74, s. 337.) This class of phenomena has been most elaborately investigated by M. Schwerd (Beugungserscheinungen, &c.).

DIFFUSION. This term has a somewhat extended application in modern science: thus we speak of the *diffusion of light,* and *of heat;* the *diffusion of gases* and *of liquids:* we also speak of a *diffusive power.* The diffusion of light is intimately related to its reflection. If we accept the optical definition of reflection, according to the law of equal angles, it would be impossible to account for the visibility of objects: the geometrical reflection would perfectly represent to the eye the source of the incident beam, but it would convey no idea of the size or colour of the reflecting surface. According to this law the image of the sun would be reflected from the surface of bodies just as if they were perfect mirrors, but the bodies themselves would not be seen: the moon would appear like a mirror reflecting the image of the sun: the candles in a room would be reflected by the walls and other objects, and nothing would be seen but the multiplied reflections of the flame. But as the surfaces of bodies are not perfectly reflective, but on the contrary, contain innumerable roughnesses which absorb a portion of the light and scatter the remainder, each roughness becomes the focus of a pencil of reflected light, the rays of which diverge equally in all directions, bearing with them the colour of the reflecting body. Thus each point of the surface forms an independent focus, by means of which each such point is made visible. This is called, somewhat improperly, *irregular reflection,* but there is nothing irregular in the phenomenon, for by means of it, light is diffused, and the illuminated objects become as it were secondary luminaries, and render objects visible which are not within the direct influence of the source of light, and these objects in their turn, by reflecting light irregularly illuminate others, and in this way the light is reverberated backwards and forwards so as to render objects visible which are far removed from any direct source of light. By means of this same property the atmosphere diffuses the light of the sun in all directions, and produces the phenomena of twilight. Similar phenomena are also to be noted with respect to heat, although it is not easy to determine the effects with as much precision. Radiant heat obeys the law of equal angles, but a portion of it that is not absorbed must be diffused by irregular reflection. This subject will come again under our notice in the article HEAT, and we content ourselves here with this slight indication of it.

The term *diffusion* as applied to gases and liquids, refers to that process by which such bodies when in contact, pass through each other and intermingle, although not necessarily related by chemical affinity. It was noticed by Priestley, that if a closed bladder containing oxygen gas be placed in a jar of hydrogen gas, the jar and the bladder will after some time each contain explosive mixtures of oxygen and hydrogen. This phenomenon, however, is now referred to *endosmosis,* or the *osmotic force.* [OSMOSE.] As an example of gaseous diffusion, we may instance the case of chlorine and hydrogen, the one being thirty-six times as heavy as the other, yet if a bottle of hydrogen be inverted, and connected by means of a long tube with a bottle of chlorine, the heavier gas will in a few hours creep up the tube to mingle with the hydrogen, and the light hydrogen will descend the tube to mingle with the chlorine, and this mixture will be equal in every part of the apparatus. Indeed, if sufficient time be allowed, this equal intermixture will take place between all gases and vapours which do not act chemically on each other. The rapidity with which this diffusion occurs varies with the density of the gases, and the more widely they differ in this respect, the more rapid is the diffusion. The rapidity with which a light gas diffuses into a heavy one may be shown by means of a *diffusion tube,* consisting of a glass tube 12 inches long, one end of which is closed with a dry porous substance, such as a plug of plaster of Paris: when this is filled with hydrogen gas at the pneumatic trough, and supported so that the water shall stand at the same level on the inside and on the outside, water will be seen to rise up the tube, and will continue to do so in opposition to gravity, until in a few minutes, it will be some inches higher than the water outside, in consequence of the gas escaping through the pores of the plaster, and diffusing itself into the air more rapidly than the air passes in and diffuses itself through the hydrogen. Experiments made in this way show that the diffusiveness of a gas is in the inverse proportion of the square root of its density. The density of air being 1, the square root of that density = 1, and its diffusiveness = 1, the density of hydrogen = 0·0692, the square root of that density = 0·2632, and its diffusiveness $\frac{1}{0\cdot2632} = 3\cdot7994$, or in an actual experiment 3·83. That is to say, while one measure of air is passing into the diffusion tube, 3·83 measures of hydrogen gas are passing out of it.

When different gases are introduced into the diffusion tube, each maintains its own rate of diffusion. The rate of diffusion is increased by a rise of temperature, but not so rapidly as the direct expansion by heat.

The process of diffusion performs an important part in nature. "Accumulations of gases, which are unfit for the support of animal and vegetable life, are by its means silently and speedily dispersed, and this process thereby contributes largely to maintain that uniformity in the composition of the aerial ocean which is so essential to the comfort and health of the animal creation. Respiration itself, but for the process of diffusion, would fail of its appointed end, in rapidly renewing to the lungs a fresh supply of air in place of that which has been rendered unfit for the support of life by the chemical changes which it has undergone." (Miller, 'Elements of Chemistry,' part i.)

The escape of a gas through a minute aperture into a vacuum is called EFFUSION, which see; and the passage of gases through capillary tubes into a rarified atmosphere belongs to TRANSPIRATION, while the passage of gases through diaphragms must be referred to *endosmosis.* [OSMOSE.]

Liquids diffuse themselves among each other, except in those few cases where they are not miscible, as in the case of oil and water, or but little miscible, as ether and water. In most cases however, the adhesion between the particles of dissimilar fluids is very perfect, so that they become completely incorporated; so much so, that an actual penetration of one body by the other seems to take place, since the mixture occupies less bulk than the liquids did separately. Thus 100 parts of alcohol mixed with 100 of water will measure only 196 parts, and the same proportions of sulphuric acid and water will measure only 185 parts.

The phenomena of liquid resemble those of gaseous diffusion. We have seen that hydrogen will descend to mix with chlorine, and that this heavy gas will ascend to diffuse itself among the particles of the hydrogen; so also, if a tall glass jar contain at the bottom one part of sulphuric acid, and over this two parts of the blue infusion of litmus, introduced so as not to mix with the acid, the heavier acid will in two or three days have diffused itself through the liquid, and the progress of the diffusion may be noted by the gradual change in colour from blue to red.

The subject of diffusion is greatly indebted to Professor Graham, who has obtained some interesting results by very simple means. His apparatus consisted of a number of 4-oz. jars with openings in the necks of 1·24 inch in diameter, for containing the trial solutions, and a number of 30-oz. cylindrical vessels for containing the small jars. The solution to be tried was poured into a 4-oz. jar to within half-an-inch of the top; it was then filled up with pure water, closed with a glass plate, and let down into the cylindrical vessel, into which was carefully poured about 20 oz. of distilled water; the glass plate was then cautiously removed, and the apparatus was kept undisturbed at a steady temperature for several days. When the result had to be examined, the mouth of the solution jar was again closed and the jar withdrawn from the vessel, the water of which was evaporated and the salt that had entered into it thus determined by weight.

From numerous experiments conducted in this way it was found: I. That when solutions of the same substance, but of different degrees of strength, were employed, the quantities diffused in equal times were *cæteris paribus* proportional to the quantity in the solution. Thus in 4 solutions of common salt, containing respectively 1, 2, 3, and 4 parts of salt per cent., it was found that in 8 days the quantities diffused were, in No. 1, 2·78 grains, in No. 2, 5·54 grains, or just double; in No. 3, 8·37 grains, or treble, and in No. 4, 11·11 grains, or four times the amount diffused from the first solution. II. That the quantities of the substances diffused from solutions containing equal weights of different bodies, varied with the nature of the substance, as in the following table. Each solution contained 20 parts of the solid in 100 parts of water, and was exposed for 8 days at a temperature of 60·5 degrees.

Substances used.	Sp. gr. of solution at 60°	Weight in grains diffused.
Chloride of sodium . . .	1·1265	58·68
Sulphate of magnesia . . .	1·185	27·42
Nitrate of soda . . .	1·120	51·56
Oil of vitriol	1·108	69·32
Sugar candy	1·070	26·74
Barley sugar	1·066	26·21
Starch sugar	1·061	26.94
Treacle of cane sugar . .	1·069	32·55
Gum arabic	1·060	13·24
Albumen	1·053	3·08

Saline substances were found to arrange themselves in groups, the members of each group being equidiffusive, and the rates of diffusion in each group connected with the rate of diffusion of the other groups by a simple numerical relation. Isomorphous salts had generally equal rates of diffusion. Seven such groups were made out. In No. 1, were hydrochloric, hydriodic, and hydrobromic acids, and perhaps also nitric acid. These acids were found to be the most diffusible substances known. Group 2, contains hydrate of potash and probably ammonia. Group 3, nitrate of potash, nitrate of ammonia, chloride of potassium, muriate of ammonia, and chlorate of potash. No. 4, nitrate of soda, and chloride of sodium. No. 5, sulphate of potash, carbonate of potash, sulphate of ammonia, and ferro-cyanide of potassium; probably also chromate and bi-chromate, bi-carbonate, and acetate of potash, and ferrid-cyanide of potassium. No. 6, sulphate and carbonate of soda; and No. 7, sulphate of magnesia. In the following table will be found some numerical results obtained by comparing together the squares of the times in which equal quantities of different salts are diffused. The second column shows the relative diffusibility of the different groups of the hydrochloric acid group; the third column gives the times required for the diffusion of equal weights of the members of each group; and the fourth shows the ratio of the squares of those times of equal diffusion.

Groups.	Rate of diffusion.	Times of equal diffusion.	Ratio of squares of times of equal diffusion.
1. Hydrochloric acid .	1·000	3·960	2
2. Hydrate of potash .	0·800	4·950	3
3. Nitrate of potash .	0·565	7·000	6
4. Nitrate of soda . .	0·462	8·573	9
5. Sulphate of potash .	0·400	9·900	12
6. Sulphate of soda . .	0·326	12·125	18
7. Sulphate of magnesia	0·200	19·800	48

III. Liquid diffusion is most regular in dilute solutions. It was also found that the quantity of a substance diffused from a solution of uniform strength increased with the temperature, but that the ratio of diffusion between different bodies at the same temperature was constant. It was found also, that of the whole quantity rather more than one-fourth was diffused during the first two days; the quantities diffused during each remaining period of two days being very nearly equal. IV. When two substances which do not combine chemically, but having different degrees of diffusibility, were mixed in solution and placed in a diffusion cell, the more diffusible substance passed out more rapidly than the other, so that a partial separation of the two bodies could be effected by this means. Thus the quantities of the carbonates of soda and of potash, diffused in the same time from a solution containing equal parts by weight, were as the numbers 35 and 65 nearly. It was even found, that in some cases chemical decomposition could be produced by liquid diffusion. Thus a solution of common alum (which is a compound of sulphate of alumina and sulphate of potash) arranged so as to diffuse into water, the sulphate of potash passed out more rapidly than the sulphate of alumina. V. It was found in the case of dilute solutions that one substance will diffuse into water which already contained another substance in solution, just as into pure water.

The reader who desires to pursue this subject further, is referred to Professor Graham's Papers, contained in the 'Philosophical Transactions' for 1850.

DIFLUAN. [URIC ACID.]

DIGAMMA, or **VAU**, is the name given by grammarians to a letter which once belonged to the ancient alphabet of the Greeks. It appears to have occupied the sixth place in that alphabet, for while *epsilon* is employed as the numerical symbol for *five*, the next letter, as that alphabet is now arranged, is the representative of *seven*. Moreover, this position of the digamma will correspond precisely with that of *vau* or *waf* of the Hebrew, and of *f* in the Latin alphabet, two letters of kindred power and form. A further argument may be found in the principles which would seem to have determined the arrangement of the Greek alphabet. [ALPHABET, vol. i., col. 235.] The letter is still to be seen in many inscriptions. [ALPHABET, vol. i., cols. 240-2, plate ii., Nos. 20, 21, 26.] With regard to the power of the letter, it is now the general and well-established opinion that it is equivalent to our own *w*. Its name has been evidently derived from the similarity of its symbol F to a repetition of the Greek *gamma* Γ.

The use of the digamma prevailed more particularly in the Æolic dialect of the Greek tongue. In the other dialects it was commonly dropped, particularly the Attic; and as this became the favourite dialect of Grecian literature, the digamma at last escaped from the alphabet; and even the Homeric poems, which had been written in a dialect still possessing the digamma, were presented to the Athenians without that letter, to the serious injury of the metre. But though the form of the digamma was not admitted into the Attic alphabet, the vowel *ο* was occasionally used, so as virtually to represent it, as in *οιδα, οικος, οινος*, equivalent to FΙΔΑ, FΙΚΟΣ, FΙΝΟΣ (comp. the Latin *video, vicus, vinum*); and it was altogether superfluous to prefix the digamma, FΟΙΚΟΣ, as was sometimes done. Other substitutions for the digamma are *β*, as *βοινος* for *Fοινος* or *οινος*, *εβαω* for *εFαω* or *εαω*, *βροδον* for *Fροδον* or *ῥοδον*, *βριζα* for *Fριζα* or *ῥιζα* (Cf. Germ. *wurz-el* and our *wort = root*); secondly, *ου*, as *Ουαρρων* for Varro; thirdly, *υ*, as *αυρηκτος* for *α-Fρηκτος* or *αρρηκτος*, *αυως* for *αFως* or *ηως*. Whether *γ* is ever substituted is disputed. Some, supported by the analogy of the French habit, as *gâter* for *vastare*, and the repeated authority not only of the Hesychian glosses but of MSS., hold that *γεθεν, γειματα* or *γηματα, γεντο* are genuine dialectic varieties of *Fεθεν, Fειματα, Fεντο*. Ahrens on the other hand regards the Γ as a clerical error for F. A still more violent substitution is that of *ρ* for *F*, as *δεδροικως* for *δεδFοικως* or *δεδοικως*, of which we have the converse in our *wubbish* for *rubbish*.

The Latin language, being more closely connected with the Æolic dialect of the Greek, is abundant in the use of this letter; for the true pronunciation of the *v* or *u consonans* must have been the same as our *w*, or it could not have so readily interchanged with the vowel *u*. The Greek words *ωον, εαρ, εσπερος, εστια, ιον*, appear in Latin as *ovum, vĕr, vesperus, vesta, viola*. In the last instance indeed there are two other points of difference, the Latin word being feminine, like *rosa* compared with the Greek *ῥοδον*; and secondly, a diminutive, which is well suited to the size of the flower. Sometimes a *b* appears in the Latin word, where the Æolic Greek must have had the digamma, as *probus* compared with *πραῢς*; or an *f*, *Formiæ* compared with *Ormiæ*.

The disappearance of the digamma in one dialect and its retention in another is in perfect accordance with what is seen in modern languages. In our own we have ceased to pronounce the *w* in *who, whose, two, sword, answer, whole;* while in *one* and *once* we have the sound without the character, and yet drop it again in *only*. The Danish dialect of the Teutonic language is remarkable for throwing off the *w*, thus *word* in the mouth of a Dane is *ord*.

For the assertions of the grammarians and the opinions of the learned with regard to the digamma, see Kidd's edition of Dawes's 'Miscellanea Critica,' pp. 175-335. The editor has given a list of the Greek words which he supposes once to have possessed this letter. A more complete discussion of the subject is to be found in Ahrens, 'De Græcæ Linguæ Dialectis.'

DIGEST. [CORPUS JURIS; JUSTINIAN'S LEGISLATION.]

DIGESTER. A strong steam-tight vessel, usually of iron or copper in which water and other materials can be heated considerably beyond their boiling points; this form of apparatus was first contrived by Papin, and is hence frequently termed Papin's digester. The following is a description of two vessels of this description which are frequently employed by chemists.

The first is constructed entirely of Low Moor wrought-iron, and consists of a cylinder A A (*fig.* 1), closed at the bottom, and welded in one piece by the steam-hammer. The cylinder is 18½ inches long, ⅝ inch in thickness, and 3 inches internal diameter; it is furnished at top with a flanch, B B, 1⅜ inch broad and ⅝ inch thick, its upper surface turned true, and having an internal annulus sunk $\frac{1}{20}$ inch below the level of the surrounding surface. The cap of the digester, C C, is made to fit upon this flanch, with which it corresponds in thickness and diameter; it is furnished with a projecting face ¼ inch deep, fitting the mouth of the cylinder exactly. Within the circle of this projecting face, the cap is perforated by two apertures, into one of which is securely fixed the cast-iron tube *d d*, closed at the bottom, 6 inches long and ½ inch internal diameter, forming a mercury bath for the reception of a thermometer. The other aperture, which is bouched with brass, serves as the bed of the safety valve *e*, which consists of a piece of brass wire ⅛ inch diameter, slightly flattened on two sides and furnished with a head accurately ground to the surface of the cap: pressure is applied to this valve in the usual manner by the lever and weight *f g*. Both the flanch and cap are perforated by four holes for the reception of four screw bolts ½ inch in diameter, which are inserted from below, and work into nuts that can be tightly screwed up by a lever key. The whole of the pressure produced by these screw bolts is made to take effect exclusively upon the surface of a leaden washer ⅛ inch thick, placed in the sunken annulus above mentioned: and thus the apparatus is made perfectly impervious to gases and vapours, even under the enormous pressure of more than 100 atmospheres. In this digester, volatile liquids enclosed in glass tubes of large dimensions and moderate thickness of glass, may be exposed to any temperature below redness with safety. Water is generally used in this digester, but other and less volatile liquids may of course be substituted if desired: in most experiments, however, it is important that the pressure upon the exterior of the glass tubes should not be much less than that in their interior, and this condition is generally secured by the employment of water in the apparatus.

Fig. 1.

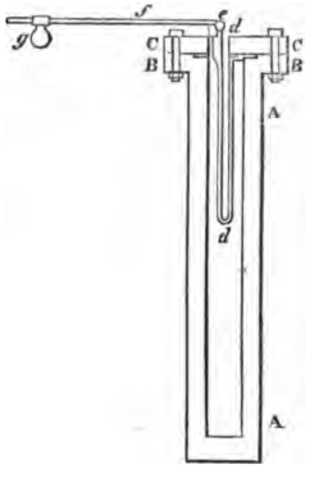
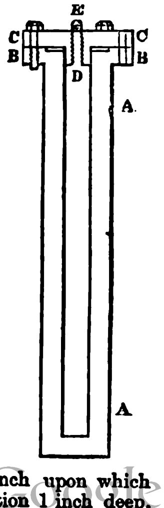
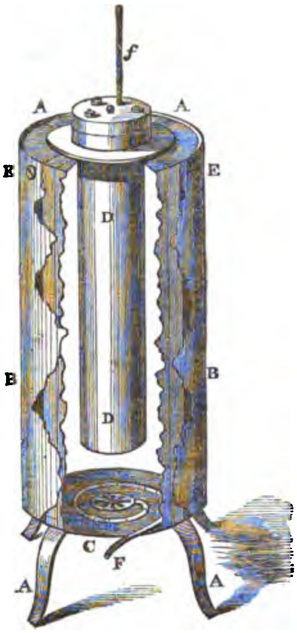


Fig. 2.



The second digester is made of wrought copper and is of smaller dimensions, being especially designed for the heating of chemical substances without the intervention of glass tubes. It consists of a wrought copper tube, A A (*fig.* 2), 18 inches long, 1½ inch internal diameter, and ½ inch in thickness, drawn from a solid mass of the metal by a recently invented process. This tube is closed at bottom by a screw plug, and is furnished at top with a brass flanch, B B, 1⅜ inch broad and 1 inch thick, screwed upon the copper tube: the vessel thus formed is closed by the brass cap C C, of the same dimensions as the flanch upon which it fits. The cap is furnished with a central projection 1 inch deep, fitting the copper tube, and pierced with a central aperture D, tapped to receive the screw plug E, which, with the intervention of a collar of lead, effectually closes the aperture. The cap C C is secured to the digester by three screw bolts ½ inch in diameter, which are inserted from above and screw into the lower flanch. Perfect impermeability to gases is secured, as in the iron digester, by a sunken annulus and a ring of lead. When it is desirable to collect the gases evolved during any operation in this digester, the plug E is replaced by a carefully made stopcock, to the nozzle of which a gas-delivery tube can be attached, when the reaction is completed. This digester is heated by means of a cylindrical copper oil-bath placed in a gas-stove, as shown in *fig.* 3. The gas-stove consists of a strong wrought-iron framework, A A, around which is fixed the sheet-iron cylinder B B closed at the bottom, but furnished with a draught regulator C, and contracted at top by a ring of sheet iron so as just to admit the cylindrical oil-bath D D, the flanch of which rests upon the upper extremities of the wrought-iron framework, which are turned inwards for this purpose. The sheet-iron cylinder is surrounded by another of polished tin plate to prevent the too rapid radiation of heat; there is an interval of half an inch between the two cases, and both are pierced with holes at E for the exit of the products of combustion. A ½-inch copper pipe, F, pierced with eighteen or twenty small apertures, forms the gas-burner. By this arrangement, it is easy to maintain an almost constant degree of heat for any length of time. The temperature is ascertained by the thermometer *f*, immersed in the oil-bath through an aperture bored in the cap and flanch of the digester for this purpose. This gas-stove is also used for heating the iron digester, but without the intervention of the oil-bath.

Fig. 3.



DIGESTION, in Chemistry, and especially in Pharmaceutic Chemistry, is the exposure of any substance to partial or total solution in a fluid, either at common temperatures or with a gentle heat: thus in the preparation of tinctures, the substance whose active principle is to be extracted is said to be *digested* in alcohol or spirit of wine, generally diluted with water. It is commonly performed in a glass flask or bolt-head which should not be more than half filled, and covered with a piece of wet bladder, so that the evaporation of the menstruum or spirit may be prevented as much as possible; if the heat be so great as to endanger the bursting of the vessel or the bladder, the latter should be pierced with one or more small holes.

The flask may be heated either by means of the sun's rays, of a common fire, or of the sand-bath, or a stove: when the heat is so great that it would occasion the loss of a valuable menstruum, as spirit of wine, without any provision for condensing it being employed, a distilling apparatus should be made use of. Formerly a method of digestion called *circulation* was resorted to; this consisted in luting a close head on the digesting vessel, in which the vapour was condensed, and ran back into the digester without loss, it being condensed in the head merely by exposure to the air.

DIGIT, a finger, a term employed to signify any symbol of number from 0 to 9. According to the original application of the term, the first ten numbers should be called digits, but universal practice employs the word to signify the ten symbols used in reckoning number. Thus ten (10) is a number of two digits.

DIGITALIC ACID. A white crystalline acid possessing a peculiar odour, and found in purple foxglove. It is very soluble in water, less so in alcohol, and still less soluble in ether. It readily undergoes spontaneous decomposition, and has not been analysed.

DIGITALIN ($C_{20}H_{18}O_8$). This name has been given to the active principle of the purple foxglove; little is known of its properties, and it has by some been supposed to be a mixture of three bodies, called *digitaline*, *digitalin*, and *digitalose*. Further, *digitalicrine*, and *digitalosine* are also the names of bodies derived from the same source. The whole subject requires re-investigation.

DIGITA'LIS PURPU'REA, fox-glove, a biennial plant, of which the leaves and seeds are used. The leaves are sometimes accidentally confounded with those of different species of Verbascum, and of the Conyza squarrosa. The most powerful leaves are those procured from plants growing on the sunny sides of hills, those of the second year only should be collected. They must be carefully dried, and protected from damp, and kept in the dark. The active principle appears to reside in an extractive substance, which by careful evaporation may be crystallised, and to which the name of Digitaline has been given. This principle is soluble in water, in alcohol, and sparingly in ether. It is very poisonous. One grain dissolved in a little water killed a rabbit in a very short time. Digitalis is given in powder, made into pills, or in an alcoholic tincture. Diversity of opinion exists respecting its primary action on the system, some writers considering it as primarily a stimulant, and the sedative effect a consequence of the previous excitement; others regarding it as a direct sedative. It is most likely that it acts in both ways according to the dose, and frequency of administration. If a small dose be given, and repeated at short intervals, a stimulant action will be most obvious, followed at a considerable interval by a sedative effect. If on the other hand a large dose be given at first, the sedative action is immediately displayed. The effect varies also with the position of the person, being different according as he is standing, sitting, or reclining.

Digitalis is the most perfect example known of a cumulative poison, as it may be used for some time, if the doses be small, without producing any manifest effect for several days, when suddenly faintness, intermittent pulse, giddiness, and other alarming symptoms appear. These are best combated by vital stimulants, such as warm brandy and water.

Digitalis has the power of reducing in a remarkable degree the heart's action, bringing down the pulse from 120 or more to 50 or 40 beats in a minute, and causing it to become at the same time intermittent. On this power depends its medical value in some diseases. It is remarkable, however, that while it thus lowers arterial action, it excites the absorbents and the kidneys to increased action, and so proves a valuable diuretic in dropsy and some other diseases. It is most useful in organic affections of the heart, and in the latter stages of some inflammatory affections, such as pneumonia, in phthisis pulmonalis, chronic peritonitis, and irritative or nervous fever. In the inflammatory or turgescent stage of hydrocephalus acutus, along with calomel, Golis states it to be very valuable.

As a diuretic, it is, like most medicines of that class, uncertain in its effects: it seldom answers if much inflammatory action exist when it is exhibited. To render it more certain it is generally given along with calomel, and squills, or some other diuretic. Digitaline has been recommended by Dr. Christison and others.

DIGITOLEIC ACID. A crystalline fatty acid, found in the purple foxglove. A number of salts have been prepared from it, but neither these nor the acid itself have been analysed.

DIGNITIES. [TITLES OF HONOUR.]

DI-IODOCODEINE. [OPIUM, ALKALOIDS OF].

DILAPIDATIONS. In its legal sense, this term is confined to the pulling down or destroying, in any manner, any of the houses or buildings belonging to an ecclesiastical benefice, or suffering them to run into ruin or decay, or wasting or destroying the woods of the Church, or suffering any wilful waste in or upon the inheritance of the Church. An incumbent is bound to keep the buildings in repair, restoring and rebuilding where necessary according to the original form, without addition or modern improvement, but he is not bound to supply or maintain anything in the nature of ornament, such as painting (unless necessary to preserve exposed timbers from decay), white-washing, and papering. For damages calculated on this principle the successor may bring his action, either in the courts of common law or in the spiritual court, against his predecessor, or, if he be dead, against his executors.

The right to damages for dilapidations, as between other persons, is governed either by the laws relating to waste and repairs, or by special contract.

DILATATION. [HEAT.]

DILATATION OF THE HEART. [HEART, DISEASES OF.]

DILIGENCE, in the law of Scotland, is an expression nearly equivalent to "process" in the law of England. It includes the various means by which the person may be seized and imprisoned, the property attached and disposed of, to the end of enforcing payment of debt or performance of any civil obligation; and witnesses compelled to give their evidence, or to produce books, writings, &c. It would not give a comprehensive view of the object of this procedure to say that it is for the purpose of carrying out the judgments of the courts of law, because it is a characteristic of Scottish procedure that not only will an agreement properly executed between parties to allow diligence to proceed without a judgment (as in a warrant to allow judgment to be entered up in England) be a sufficient warrant for diligence, but there are certain pecuniary obligations, of which it is the characteristic that summary or the more rapid kind of diligence can proceed on them if they are not in any way vitiated or imperfect. These documents are bills of exchange and promissory notes, and the facility of recovering the debts contained in such documents, by a rapid method of execution, is a marked feature in the mercantile code of Scotland, and one which is believed to have beneficial effects. Before diligence can issue, such a document must be protested and registered in the books of some competent court, and thence the diligence issues, as if it were founded on the decision of the court. The registers being accessible to the public on payment of certain fees, this facility for tracing the initial steps of bankruptcy is made use of by members of the mercantile community of Scotland, who have a machinery by which they can inform each other of the persons whose names appear on the register.

Diligence is either against the person, by imprisonment, or against the estate, by attachment and sale. The latter class is divided into two kinds—that against the heritable or real estate [ADJUDICATION], and that against the moveable. This latter admits of a subdivision into an attachment of property in the debtor's possession, called in the ordinary case Poinding [POINDING], but where it is by a landlord for rent, sequestration; and an attachment, in the hands of a person who is owing money to the debtor or holds property belonging to the debtor in his custody. [ARRESTMENT.] Formerly diligence, in the greater number of cases, proceeded on the clumsy fiction that the debtor, being charged to pay in the name of the sovereign and refusing, was to be denounced a rebel by a messenger at arms, who certified that he performed the denunciation by three blasts of a trumpet, and it was nominally as a rebel that his person or estate was seized. A more simple and economical procedure has now been substituted.

DILITURIC ACID. An acid, the existence of which has not been fully proved, said to be produced by the action of boiling hydrochloric acid upon alloxantine.

DILUENTS comprise those liquids which are used to dilute the fluids of the human body, and thereby modify their nature. They are employed when the secretions are too viscid, or the contents of the stomach, of the intestines, or any of the glands are too acrid, and also when the heat of the body, as indicated by thirst, &c., is too great, and causes a feeling of uneasiness. They manifest their beneficial effects most quickly when the contents of the stomach or upper part of the intestines require to be diluted, as in the case of many poisons; but they also reach the kidneys or skin in a very short time after their introduction into the system, and render less acrimonious the secretions of these organs. Their utility in allaying the thirst of patients affected with fevers and other inflammatory complaints is well known, and from such patients they ought never to be withheld, as they were at one time, when erroneous notions on the subject prevailed, as they not only mitigate the sufferings of the invalid, but often determine to the skin, and cause a critical perspiration. It is equally cruel and injurious to withhold drinks of a mild kind from dropsical subjects, though they require to be used by such persons in greater moderation.

Water is the simplest, and often the best diluent, but it may be rendered more agreeable in some cases by being made into toast-water, or by having acid or other substances added to it. Whey or buttermilk are also agreeable diluents in many cases. The excessive use of fluids at meal-times seems to be hurtful to digestion; and diluents appear to be less proper for persons of a soft and lymphatic constitution than for the robust and sanguine. Children of a scrofulous constitution do not prosper so well on a fluid as on a dry diet; they should therefore be allowed liquids in a very moderate degree, especially towards evening. A dry diet is rigidly enforced on all persons training for athletic feats.

DIMENSION (algebra), a term which is used in the same sense as DEGREE. Thus x^2y is of three dimensions or of the third degree. In geometry, length is of one dimension, surface of two, and solidity of three. Thus geometry of three dimensions means solid geometry.

DIMETHYLALLOXANTIN. [AMALIC ACID; CAFFEINE.]

DI-METHYLAMINE. [ORGANIC BASES.]

DIMETHYLMUREXID. [CAFFEINE.]

DIMETHYLOXAMIDE. [OXAMIDE.]

DIMETHYLPARABANIC ACID. [CAFFEINE.]

DIMETHYL-UREA. [UREA.]

DIMORPHISM. [ISOMORPHISM.]

DINAPHTYL-CARBAMIDE ($C_{42}H_{16}N_2O_2$). A derivative of carbamide, prepared by the action of heat upon oxalate of naphtylamine.

DINAPHTYL-SULPHOCARBAMIDE ($C_{42}H_{16}N_2S_2$). An unimportant derivative of carbamide. It is dinaphtyl-carbamide in which the oxygen is replaced by sulphur. [DINAPHTYL-CARBAMIDE.]

DINITRANILINE ($C_{12}H_5(NO_4)_2N$). [ANILINE.]

DINITROBENZOIC ACID. [BINITROBENZOIC ACID.]

DINITROBENZOLE. [BENZOLE.]

DINITROETHYLIC ACID ($N_2C_4H_5O_3$). An acid obtained in combination with oxide of zinc by the action of zincethyl upon binoxide of nitrogen. This acid may be regarded as a double equivalent of binoxide of nitrogen (N_2O_4), in which one atom of oxygen is replaced by one of ethyl, the reaction being quite analogous to that by which Wanklyn succeeded in producing propionic acid from sodium-ethyl and carbonic acid. Dinitroethylic acid is therefore an analogue of propionic acid. The acid itself is very unstable, and many of its salts deflagrate violently on exposure to heat.

DINITROPHENYL-CITRACYNAMIC ACID ($C_{10}H_6(C_{12}H_3(NO_4)_2)NO_6$). A derivative of citric acid.

DI'OCESE (*διοίκησις*, *dioikēsis*, literally "administration"), in the time of Constantine and afterwards was used to designate one of the civil divisions of the empire; but it is now used only in reference to ecclesiastical affairs. A diocese is a district over which the authority of a bishop extends. It is equivalent to BISHOPRIC.

DIOCLES. [CISSOID.]

DIO'NE, an ocean-nymph, or female Titan, was, according to Homer and Hesiod, the daughter of Oceanus and Tethys; but some later writers make her the daughter of Uranus and Ge. She was the mother of Aphrodite by Zeus; and Homer describes her as receiving Aphrodite in Olympus, after that goddess had been wounded before Troy, and soothing her with the assurance that Diomedes should die early and childless. ('Iliad,' b. v., 370-406.) Dione was worshipped in the temples of Zeus, and had a grove dedicated to her at Lepreon, in the Peloponnesus. She is often represented by Greek sculptors: usually with a certain resemblance to Aphrodite, but of a fuller and more matronly form. The beautiful statue in the second Græco-Roman saloon at the British Museum, commonly called the Townley Venus, is by several authorities considered to represent Dione, and it now bears the inscription Aphrodit or Dione.

[Dione, or Aphrodite: from a marble statue in the British Museum.]

DIONY'SIA (Διονύσια), festivals held in honour of the god Dionysus. The most important of such festivals, and those which alone deserve to be specially mentioned, were held at Athens and in Attica; and these are important by reason of their being the occasions on which all the dramatic exhibitions of the Athenians took place. Both the tragedy and comedy of the Athenians arose ultimately from parts of ceremonies, which prevailed in very early times among the Greeks, at the festivals of Dionysus (Aristot. 'Poet.' 4. 14); and it is alike a consequence and a proof of this origin, that the dramatic exhibitions and contests among the Athenians, from the earliest to the latest times at which we can trace them, always took place at some one of the Attic Dionysia.

These Attic Dionysia were four in number. Enumerated in the order of time, according to the Attic year, they were: 1, the Lesser or Rural Dionysia, held in the month Poseideon; 2, the Lenæa, held in the month Gamelion; 3, the Anthesteria, held in the month Anthesterion; and 4, the Great or City Dionysia, held in the month Elaphebolion. They were held in four consecutive months, the first of which, Poseideon, coincides with part of December and part of January, and the last, Elaphebolion, with part of March and part of April.

We proceed to speak of these festivals separately, and in the order in which they occurred in the Attic year.

1. *The Rural or Lesser Dionysia*, was a festival celebrated all over Attica, the other three being confined to Athens. This appears to have been the oldest of the Dionysia. It was a festival of the vintage, and though it may appear to have been held somewhat late in the year (in the latter part of December), it was not held later than the vintage now takes place, in a more rigorous climate, in some of the vineyards producing the Tokay wine. The Rural Dionysia were celebrated by means of separate festivals in all the demes of Attica; the expenses of these separate festivals fell on the several demes and the performances, processions

and banquets, of which the festivals consisted, were under the superintendence of the several demarchs. It is inferred from the law of Evagoras, cited by Demosthenes (Mid. p. 517), and an inscription contained in Boeckh's Public Economy of Athens (App. viii.), that Athens joined, on the occasion of the Rural Dionysia, in the festival celebrated at Piræus. At the dramatic performances of these rural festivals, plays that had before been represented either at the Lenæa or the Great Dionysia, used to be repeated. Of the procession, in which was carried the phallus, and in which was sung the phallic hymn, there is a sketch in miniature in the 'Acharnians' of Aristophanes (v. 230, fol.). At all these festivals great licence of speech and conduct was allowed; but at this the licence was the most unbounded.

2. *The Lenæa*, so called from a wine-press (ληνὸς), whose erection, in an inclosure called for the same reason *Lenæum*, lying originally a little out of the city and near a marsh (Λίμναι), it was supposed to commemorate, may, like the Rural Dionysia, be considered a vintage-festival. Boeckh thinks that a festival that went by the name of *Ambrosia* was the same with the Lenæa. The Lenæa were celebrated also among the Ionian states in Asia Minor, they having carried over with them at their migration the custom of the mother-country; and the Attic month Gamelion, in which the Lenæa were held, received in the Ionian calendar the name Lenæon. In Athens, the Lenæa were under the superintendence of the king-archon, and were celebrated with a public banquet at the expense of the state, a procession, and with dramatic exhibitions. As regards these last, we find that they consisted chiefly of new comedies. There are, however, instances of tragedies represented at the Lenæa, as also of comedies at the Great Dionysia, in the performances at which festival tragedies greatly predominated. It will help to show the relation between the Lenæa and the Great Dionysia that at the former foreigners were not, as at the latter, excluded from choruses, and also that the resident aliens (μέτοικοι) might at the Lenæa serve as *choragi*, which again was not permitted at the Great Dionysia.

3. *The Anthesteria*, deriving its name from the time of year at which it was held, the month of flowers, is a festival differing materially from the other three, inasmuch as it appears to have comprehended no public dramatic performances. It is inferred however by Hermann, from a law mentioned in the Lives of the Ten Orators (Pseud. Plut. vi. p. 253), and from other stray allusions to contests taking place at this festival, that plays were now rehearsed before small audiences, which were to be performed at the Great Dionysia in the succeeding month. Neither was there at the Anthesteria, as at the Lenæa and Great Dionysia, a public banquet provided by the state; but a certain sum, it is supposed, was given to each citizen, with which he was to provide his own repast. (Plut. 'Resp. Ger. Pr.' c. 25.) The festival lasted during three days, which respectively bore the names *Pithoegia*, *Choes*, and *Chytri*. On the first day, as is to be inferred from the name, the wine of the preceding vintage was broached and tasted, and on the second, we may suppose, the new wine was drunk. It was on this day that persons were initiated in the mysteries of Dionysus. On the second day there were various games; on the third, flowers, &c. were offered to the god. This was accounted a festival of great sanctity, and included many mysterious ceremonies for which none but the wife of the king-archon and a small number of priestesses (γέραιραι) were qualified. One ceremony was a mock marriage between the king-archon's wife and Dionysus. (Demosth. 'Neær.' p. 1369.) The Anthesteria were, like the Lenæa, under the superintendence of the king-archon. As during the Roman Saturnalia, the slaves enjoyed a temporary freedom during this festival; it was a custom also to send presents, and, as at the Roman Quinquatria, to pay one's instructors on the occasion of the Anthesteria. (Athen. x. 437.)

4. *The City or Great Dionysia*, or *Dionysia* without any epithet, the most splendid of the four festivals, were under the superintendence of the chief archon (ἄρχων ἐπώνυμος). This festival was held at a time when Athens was filled with foreigners, those bringing the tribute from her dependent states, and others. (Aristoph. 'Ach.' 474, &c.) It was celebrated with a public banquet at the expense of the state, with a magnificent procession, and with dramatic performances, which consisted chiefly, as has been said in describing the Lenæa, of tragedies. Plays which had once won a prize were not allowed to be repeated, though a special exemption from this rule was granted to the plays of Æschylus upon his death, and subsequently to those of Sophocles and Euripides.

The times and occasions of the institution of these several festivals are wrapped in obscurity. The Rural Dionysia, Lenæa, and Anthesteria, were connected with a rural worship of Dionysus [DIONYSUS], and were, it may be safely said, antecedent to the Great or City Dionysia; and it is, in comparison with this festival that Thucydides (ii. 15) calls the Anthesteria, more ancient. The Lenæa and Anthesteria were festivals held in the deme Lenæus before it was inclosed within the city. The institution of the great Dionysia seems to be referred to in a legend, which relates that Pegasus brought an image of Dionysus Eleuthereus from Eleutheræ to Athens. Boeckh connects this with an historical tradition of the migration of the Eleutherians from their town to Athens, and conjectures that the migration, and, as he supposes, consequent institution of the Great Dionysia, preceded by a little the return of the Heraclides (1124 B.C.). Welcker, who assigns to the epithet Eleuthereus and other epithets of Dionysus a political meaning, connects with the progress of his rites in the Athenian state the progress of political liberty.

The grand features of these festivals were the dramatic performances, the secret rites, and the public processions. Of the dramatic performances we have spoken above. Of the secret rites little is really known. The processions were what perhaps most distinguished them in the popular eye from the other public festivals of Attica. The Dionysia were a season when riotous merriment and drunkenness were universal. The bounty of the wine god was symbolised in the unlimited enjoyment of his worshippers. In the procession Dionysus himself was represented, attended by Nymphs, Lenæ, Bacchantes, Fauns, Satyrs, &c. The men, drunk with wine, were disguised with skins and masks, their bodies were painted, they were crowned with garlands of ivy, and carried thyrsi in their hands; while the female bacchantes, &c., danced along in a state of ecstatic phrensy. These Dionysian processions afforded favourable opportunities for the display of the freer forms of Greek art, and some of the most beautiful relievi, sculptured and painted vases, &c., have Dionysian processions or characters for their subjects. Many of these may be seen in the British Museum. The beautiful figure of a bacchante engraved below is supposed to be the work of Scopus. The cut of a Dionysian procession is from a large marble vase.

[Bacchante, from the British Museum.]

The *bacchanalia*, as the Roman festive rites in honour of Bacchus were called, must be distinguished from the Greek Dionysia. The bacchanalia were celebrated every third year, and were hence called trieterica. At them a mixed crowd of men and women, intoxicated with wine, clothed in deer-skins and Asiatic robes, and carrying thyrsi in their hands, ran up and down the country shouting, beating drums and cymbals, and crying, "Evoe! Io Bacche! Evan!" &c. They are said to have been introduced into Rome from Etruria. (Liv. xxxix. 8.) Such fearful excesses, however, were early brought into practice at the secret initiatory rites, that in the year 186, B.C., the consuls laid a report of the proceeding before the senate, and afterwards before an assembly of the people, and were, in consequence of the disclosures, invested with extraordinary powers for their suppression. They accordingly issued a proclamation for the suppression of the bacchanalian orgies throughout Italy; and directed all persons known to have participated in the private meetings to be summarily arrested. As many as 7000 persons are said to have been initiated; and the trials of those seized lasted thirty days. Henceforth only a simpler and comparatively harmless festival, the *Liberalia*, was celebrated in Rome annually, on the 16th of March. It was on this day that Roman youths were invested with the toga virilis.

[Dyonisian Procession, from a Vase in the British Museum.]

DIONY'SUS (Διόνυσος), and later Bacchos (Βάκχος) of the Greeks, Bacchus of the Romans, the god of wine, the representative among the male deities of the productive power of nature. In the common narrative he appears as the son of Zeus and Semele. Hera, being jealous of Semele, assumed the form of her old nurse Beroë, and thus persuaded Semele to request Zeus to visit her in his majesty as he was accustomed to visit Hera. Zeus having beforehand promised to grant her prayer, was obliged to comply, and the consequence was, as Hera foresaw, that Semele was destroyed by the lightning of the thunder-god. But before she perished she gave premature birth to Dionysus, who was taken by Zeus and enclosed in his thigh till he arrived at maturity. During his infancy Dionysus was nourished by the nymphs in Naxos, and Hermes and the Muses assisted in his education on Mount Nysa. When he grew towards manhood Hera threw him into a fit of madness, as she had before done to some of the nymphs who had followed him. In this state he wandered long and far over the earth, bestowing rewards on those who treated him kindly, and punishing those who refused to welcome him or accept his gifts. In the course of his wanderings he visited Rhea, who instructed him in the mysteries which afterwards formed so important a part in his worship. He was accompanied wherever he went with a crowd of attendants, consisting of Bacchantes, the Lenæ, the Naiades and Nymphs, the Thyades, the Mimallones, the Tityri, Pan, Silenus, the Fauns, and the Satyrs, whose riotous and frenzied proceedings typified the influence of the fruit of the grape, the culture of which he disseminated throughout the earth. The various adventures of Dionysus whilst on the earth are told by the Greek and Roman writers at great length; but they are too well known, and would require too much space to recapitulate here. When he had completed his wanderings, he was received into Olympus, whither he carried also his mother, having brought her out of Hades, and changed her name to Thyone.

The worship of Dionysus seems to have arisen from that "striving after objectivity" (Wachsmuth, 'Hellen Alterthum,' ii. 2, p. 113) which is the characteristic of a primitive people, and which leads man in his rude state to the worship of the active and productive powers of nature. It does not fall within the nature of this work to discuss the inferences drawn from the old traditions by modern mythologers. These deductions, and especially the description of the mystical character of Bacchus, as distinguished from his worship as the god of wine, may be seen fully developed by Creuzer ('Symbolik,' theil. iii. pp. 83, 266; pp. 319–366), whose theory, however, of the Indian origin of the Bacchic rites, though ingenious, does not appear to be established by sufficient external evidence. The southern coast of Thrace seems to have been the original seat of this religion, and it was thence introduced into Greece shortly after the colonisation by the Æolians of the Asiatic coast of the Hellespont. The admission of the identity of Osiris and Dionysus by Plutarch and other mythological theorists, as well as Herodotus's simple statement of the assertions of the Egyptian priests to that effect, is no proof of the common origin of the worship of this divinity in Egypt and Greece; but there is no doubt that certain modifications of the Dionysian rites took place after the commencement of the intercourse of the Ionians with the Egyptians. These rites, the distinguishing feature of the worship of Dionysus, have been already described. [DIONYSIA.]

The worship of Bacchus is intimately connected with that of Demeter: under the name of Iacchus he was worshipped along with that goddess at Eleusis. [DEMETER; ELEUSINIA.] Virgil invokes them together ('Georgics,' i. 5) as the lights of the universe. According to the Egyptians they were the joint rulers of the world below. (Herod. ii. 123.) Pindar calls Dionysus "the companion of Demeter" (χαλκοκρότου πάρεδρον Δαμάτερος), and in a cameo he is represented sitting by the goddess in a chariot drawn by male and female centaurs. (See Buonarotti, 'Osservazioni sopra alcuni Medaglioni Antichi,' p. 441; Mariette, 'Traité des Pierres Gravées,' t. ii. p. i.)

Dionysus himself, his adventures, and his associates, were among the most favourite subjects of Greek and Græco-Roman art. Müller has very tersely and clearly indicated the range and character of the Dionysian life and cycle. "The whole of the wondrous life of Dionysus—at least, so far as it did not withdraw itself from representation by a decidedly mystical tendency—admits of being traced in works of art First, the significant double-birth from Semele's dead body and the thigh of Zeus; then how Hermes carries the child, carefully wrapped up, to his nurses, the august form of the earth receives it, the nymphs and satyrs cherish it, and his divine and wondrous nature is unfolded amid joyous sports. Then how, surrounded by the noise and tumult of his thiasos, he finds the gracious bride Ariadne (a Cora of the Naxian worship), at the same time, however, without active participation, and, as it were, wrapped in a pleasing dream, and then rides to meet her, or with her, in a bridal chariot (wherein the leading of Ariadne up to Olympus may suggest itself to the mind). The Naxian solemnisation of the nuptials becomes itself a representation of the gayest and happiest life, in all abundance of the gifts of nature. But Dionysus also appears, in a work of the best period of art, in a gracefully tender relation to his mother, who is restored from the nether world. Lastly, we see him in the circle of frenzied Mænads, subduing and punishing Pentheus and Lycurgus, the insulters and foes of his worship, and also the piratical Tyrrhenians, by means of his bold satyrs, and in rich relievo representations (in which the victorious

[The Bearded Dionysus and a Bacchante, from a bas-relief in the British Museum.]

[Bust of the Bearded Dionysus, from the British Museum.]

expeditions of later Macedonia were mythically typified) celebrating the triumphs of the conquest of India." ('Ancient Art,' p. 492.)

On the form and dress of Dionysus almost all the ancient testimonies have been collected by F. G. Schön in an ingenious dissertation on the costume of the characters in the Bacchæ of Euripides; and by Müller as above. The earliest forms of the god represented him as a man of mature age, with luxuriant curling hair, bound by the mitra, with a flowing beard, and open expression of face, and enveloped in ample drapery: when this form occurs in late examples, it is usually termed the Indian Bacchus. Many busts of this kind occur, as also many examples in relievo. Later he was represented as a young man with an effeminate face (*θηλύμορφος*, Bacch. 353; Euseb. 'Chron.' p. 29), with long blond hair (Bacch. 455, 'Cycl.' 63), with a fillet on his head (Strabo, xv. p. 1038), or an ivy crown ('Cycl.' 593), with a long purple robe and a nebris (deer-skin), and with a thyrsus in his hand.

[The Youthful Dionysus attended by a Faun, from a bas-relief in the British Museum.]

The Greek Dionysus seems to have been confounded by the Roman poets with Liber, an early Italian deity, who presided over the cultivation of corn and the wine, and who was associated with the worship of a female deity Libera and Ceres. Libera came, therefore, according to the Roman custom of uniting a female with a male divinity [Bellona], to be regarded as the feminine counterpart of Bacchus; and instances occur where they are represented united in one figure.

[Bacchus and Libera, from the British Museum.]

Bacchus is also spoken of by Roman poets, and occasionally represented by sculptors, as androgynous, or partaking in himself of both sexes. But a clearer notion will be obtained of the artistic idea of Dionysus and his associates from a visit to the British Museum, than from any description within the narrow limits of a cyclopædia. In the Second Græco-Roman Saloon will be found a number of Bacchic representations, arranged together under the title of the Dionysiac Cycle, including statues, busts, and masks of Dionysus, both bearded and youthful; groups of the god and various personages; statues of Libera, Pan, Fauns, Satyrs, and Bacchantes, with relievi of Dionysian processions, &c., while in the magnificent collection of fictile vases in the Vase Rooms are numerous paintings of scenes from the Dionysia.

DIOPTRICS. [Optics; Refraction.]

DIORA'MA, from the Greek word *διορᾶν*, to see through, a mode of painting and scenic exhibition invented by two French artists, Daguerre and Bouton, which, although it does not possess some of the advantages of the panorama, produces a far greater degree of optical illusion, and is therefore much better adapted for architectural and interior views. The peculiar effect of the diorama arises, in a considerable measure, from the contrivance employed in exhibiting the painting, which is viewed through a large aperture or proscenium. Beyond this opening the picture is placed at such a distance that the light is thrown upon it, at a proper angle, from the roof, which is glazed with coloured glass, and cannot be seen by the spectator. Besides the light being thus concentrated upon the picture, the effect is materially increased by the spectator being in comparative darkness, receiving no other light than what is reflected from the surface of the painting itself, and sitting at some distance from the picture. The contrast occasioned by confining the light to the picture, and the exclusion of all other objects of vision, save those represented in the painting, so that the eye has no immediate standard of comparison between them and real ones, give to this species of exhibition so much force that a very moderate degree of light will suffice to show the painting. Hence the light may be diminished or increased at pleasure, and that either gradually or suddenly, so as to represent the change from ordinary daylight to sunshine, and from sunshine to cloudy weather, or to the obscurity of twilight; also the difference of atmospheric tone attending them. These transitions, in regard to light and atmospheric effects, are produced by means of different folds or shutters attached to the glazed ceiling, which are so contrived that they may be immediately opened or closed to any extent, thereby increasing or diminishing the light just as required, and otherwise modifying it. Further than this, some parts of the painting itself are transparent, and on them the light can occasionally be admitted from behind, thereby producing a brilliancy far exceeding that of the highest lights of a picture upon an opaque ground, which can be made to appear vivid and sparkling only by contrast, not by any positive increase of light on those parts of the surface. The combination of transparent, semi-transparent, and opaque colouring, still further assisted by the power of varying both the effects and the degree of light and shade, renders the diorama, in competent hands, perhaps the most perfect scenic representation of nature, and adapts it peculiarly for moonlight subjects, or for showing such *accidents* in the landscape as sudden gleams of sunshine and their disappearance, as well as for architectural interiors. The diorama was exhibited first at Paris in 1822, and then in London in 1823, where a spacious building was erected for the purpose in the Regent's Park: but here, though at first very successful, it after a time ceased to attract, and was discontinued, and the building was converted into a Baptist chapel.

DIOSMIN. A non-azotised bitter matter found in the leaves of the *Diosma crenata*. Its composition is not known.

DIP; DIPPING NEEDLE. [Magnetism.]

DIPHENINE ($C_{24}H_{12}N_4$). A yellow crystalline alkaloid derived from *benzole*.

DI-PHENYL, a double prefix, used in organic chemistry to denote the presence of two equivalents of phenyl in the body to which it is immediately attached: thus *diphenyl-carbamide* signifies carbamide containing two equivalents of phenyl. Any chemical substance the name of which begins with this prefix, and which is not found in its alphabetical position, will, if of any importance, be found described under the name without one or both of the prefixes: thus, *diphenyl-oxamide* will be found described either under Phenyl-Oxamide or Oxamide.

DIPHTHERITE or DIPHTHERITIS (from *διφθέρα*, a skin or membrane), a term applied by M. Bretonneau and other French writers to a peculiar inflammation of the mucous membrane of the throat or pharynx, which is accompanied by the production of a false membrane. This disease first attracted attention at Tours in France, where it prevailed as an epidemic in 1818. It subsequently appeared in other towns in France, and alarmed the inhabitants of Boulogne in 1856. It has also been seen in India since its discovery and description by Bretonneau. No cases seem to have been accurately observed in this country till 1857; but since that time it has broken out in many parts of England, and presented its most characteristic symptoms. When this disease was first described, it was regarded by some writers in this country as a variety of croup, and by others as a form of scarlet fever. Now that it has appeared, few observers could be found who would not agree that it is a disease *sui generis*. The invasion of this disease has been looked on with greater anxiety, as there seems to be little doubt of its belonging to the contagious or communicable class. It is also very fatal, and already a large amount of mortality has been caused by it in this country.

The distinguishing feature of this disease is the formation of a false membrane upon the surface of the mucous membrane of the fauces. This membrane is of a whitish or ash-gray colour, and frequently extends forwards from the pharynx and tonsils to the soft palate and into the nostrils, and backwards into the œsophagus. It is seldom found in the larynx and the trachea, and in this respect it differs from croup, and may be easily distinguished from it. When the membrane is found in the larynx or trachea, it is always subsequent to its appearance in the fauces, and in these cases it is most fatal. At the commencement of the disease, the membrane is seen in the form of a white spot on the pharynx or tonsils, from which it gradually extends all around. As it goes on, the membrane comes away in spots or presents fissures, through which the mucous membrane may be seen of a deep red or even of a purplish and claret colour. During the progress of the disease the cervical and submaxillary glands become swollen, and there is a fetid discharge from the nose and mouth. As the sloughs separate from the fauces, hæmorrhage frequently occurs.

The general symptoms are those of low fever. The disease sets in with shivering and intense depression, there is dryness and tingling of the throat and ears, difficulty of swallowing, vomiting, and very frequently headache. The tongue is loaded, the pulse is frequent and feeble. In the early stages it might be taken for scarlet fever. But there is no active fever, no eruption of the skin, no redness of the papillæ of the tongue, and when the patient recovers, no desquamation of the cuticle, as is constantly the case in that disease.

The prognosis in these cases is unfavourable. This disease generally terminates life by extending to the air passages and producing effusion in the glottis, which speedily terminates life.

This disease is from the beginning attended with a great depression of the vital powers, and its treatment demands that the vital processes should be sustained. A purgative may be given at the onset, but in most cases wine may be administered from the commencement of the attack. Many writers also speak highly of the chlorate of potash administered in the same way as in scarlet fever. To this may be added the preparations of ammonia. Quinine has also been highly commended, with the mineral acids. Many writers speak highly of the tincture of the sesquichloride of iron. The throat also requires local treatment. Two remedies have been generally employed, nitrate of silver and chlorine. The nitrate of silver is applied in the proportion of one drachm to an ounce of water on a sponge several times in the course of a day. Dr. Watson recommends injecting the nares with a solution of chlorine in water. This relieves the fetid smell which is very disagreeable to the patient and those around. The chlorate of potash may also be given in a linctus to lubricate the fauces, and when swallowed to act on the system.

Although this disease appears to arise where local causes predispose individuals to its occurrence, there can be no doubt that it is a communicable disease. It frequently goes through a whole family, attacking young and old. This is more especially the case in houses where the ventilation is bad, and where the drains and water-closets have been neglected. It seems especially active in houses with unemptied cess-pools and undrained privies. The disease is, however, communicated to those beyond these influences, and in many instances nurses and medical men have been attacked with the disease after attendance upon those who are afflicted with it. When the disease breaks out, the rest of the family should be removed from the house, and its sanitary condition attended to.

DIPHTHONG (δίφθογγος) is the sound of two vowels pronounced in rapid succession, as the German *au* in *maus*, pronounced precisely like the English word *mouse*, the vowel sound consisting of the broad *a* of *father*, followed quickly by the sound of *u* or *oo*. Again, the *i* in the English word *mind*, though represented by a single character, is virtually a diphthongal sound, consisting of the broad *a* of *father*, followed by the vowel sound which is heard in *mean*. The name diphthong however is commonly given to any vowel sound represented by the junction of two vowels, as in *dream*, though the sound produced is not compounded.

All diphthongs are said to be long syllables; and this would be true if they were only employed to mark the union of two vowel sounds. This probably was originally their sole office; for in many English words now written with diphthongs, but pronounced as if they had single vowels, an earlier pronunciation contained the double sound; and indeed this view is often supported by the provincial pronunciation of a word. For example, such words as *meat*, *dream*, *boat*, are pronounced in many parts of England as disyllables, *meät*, *dreäm*, *boät*. In practice however a diphthong is often used where the vowel sound is not only uncompounded but short, as in *friend*, *breadth*.

Again, diphthongs are occasionally used to represent simple sounds intermediate between the vowels, as in the English word *cough*, the French *fait* and *au*, and the German sounds represented by *ae*, *oe*, *ue*, commonly written *ä*, *ö*, *ü*, where the dots placed over the vowels are merely a corruption of the letter *e*.

DIPLOMACY is a term used either to express the art of conducting negotiations and arranging treaties between nations, or the branch of knowledge which regards the principles of that art and the relations of independent states to one another. The word comes from the Greek diploma, which properly signifies anything doubled or folded, and is more particularly used for a document or writing issued on any more solemn occasion, either by a state or other public body, because such writings, whether on waxen tablets or on any other material, used anciently to be made up in a folded form. The principles of diplomacy, of course, are to be found partly in that body of recognised customs and regulations called public or international law, partly in the treaties or special compacts which one state has made with another. The superintendence of the diplomatic relations of a country has been commonly entrusted in modern times to a minister of state, called the Minister for Foreign Affairs, or, as in England, the Secretary for Foreign Affairs. The different persons permanently stationed or occasionally employed abroad, to arrange particular points, to negotiate treaties commercial and general, or to watch over their execution and maintenance, may all be considered as the agents of this superintending authority, and as immediately accountable to it, as well as thence deriving their appointments and instructions. For the rights and duties of the several descriptions of functionaries employed in diplomacy, see the articles AMBASSADOR; CHARGÉ D'AFFAIRES; CONSUL; ENVOY.

DIPLOMATICS, from the same root, is the science of the knowledge of ancient documents of a public or political character, and especially of the determination of their authenticity and their age. But the adjective, diplomatic, is usually applied to things or persons connected, not with diplomatics, but with diplomacy. Thus by diplomatic proceedings we mean proceedings of diplomacy; and the *corps diplomatique*, or diplomatic body, at any court or seat of government, means the body of foreign agents engaged in diplomacy that are resident there.

Among the most important works upon the science of diplomatics are the following: Wicquefort's 'L'Ambassadeur et ses Fonctions,' 1764; Count Garden's 'Traité complet de Diplomatie, par un Ancien Ministre,' 1833; Winter's 'Système de Diplomatie;' 1830. Among the works relating to diplomacy is the collection of treatises by G. F. von Martens, continued by C. von Martens, Koch, Schöll, Klüber, and P. A. G. von Meyer.

DIPPEL'S OIL. Synonymous with *bone oil*. [BONE LIQUOR.]

DIPTERAL. [GRECIAN ARCHITECTURE.]

DIRECT and RETROGRADE, two astronomical terms, the former of which is applied to a body which moves in the same direction as all the heavenly bodies except comets; the second to one which moves in a contrary direction. The motions of the planets round the sun, of the satellites round their primaries, and of the bodies themselves round their axes, all take place in one direction, with the exception only of the comets, of which about one-half the whole number move in the contrary direction. The course of these celestial motions is always from west to east, which is the *direct* course. The *retrograde* is therefore from east to west. The real diurnal motion of the earth being direct, the apparent motion of the heavens is retrograde, so that the orbital motion of the sun and moon has, so far as it goes, the effect of lessening the whole apparent motion: or these bodies appear to move more slowly than the fixed stars. With regard to the planets, the effect of the earth's orbital motion combined with their own, makes them sometimes appear to retrograde more in the day than they would do from the earth's diurnal motion only. [PLANETARY MOTIONS.] In the Latin of the 17th century, the direct motion is said to be *in consequentia*, and the retrograde *in antecedentia*. The most simple way of remembering direct motion, is by recalling to mind the order of the signs of the zodiac. From Aries into Taurus, from Taurus into Gemini, &c., up to from Pisces into Aries, is direct motion; while from Taurus into Aries, from Aries into Pisces, &c., is retrograde motion.

DIRECTION, a relative term, not otherwise definable than by pointing out what constitutes sameness and difference of direction. Any two lines which make an angle point in different directions; a point moving along a straight line moves always in the same direction. Permanency of direction and straightness are equivalent notions. A body in motion not only changes its direction with respect to other bodies, but also the direction of other bodies with respect to it.

The most common measure of direction, for terrestrial purposes, refers to the north as a fixed direction, and uses the points of the compass. But any line whatever being drawn from the point of view, the directions of all other points may be estimated by measuring the angles which lines drawn from them to the point of view make with the standard line.

When a point describes a curve, it cannot at any one moment be said to be moving in any direction at all; for upon examining the basis of our notion of curvature, we find that it consists in supposing a line to be drawn, no three contiguous points of which, however near, are all in the same straight line. But this is a mathematical notion, which is contradicted in practice by any attempt at a curve which we can make on paper. For it is found that, as must be the case from the proposition mentioned in the article ARC, when two points of a curve are taken very near to each other, and joined by a chord, the widest interval between the chord and the arc disappears or becomes imperceptible long before the chord and arc disappear. Hence arises the notion that a curve may in fact be composed of very small straight lines, each of which has of course a definite direction. But though such notion must be abandoned in geometry, yet it leads to the stricter notion of a TANGENT [see also CONTACT], or of a straight line of which, as soon as the term is explained, we unhesitatingly admit,—1, that if a line moving on a curve be said to have a direction at all at any point, the direction must be that of a tangent at that point; 2, that it is highly convenient to say that a point moving in a curve is moving in a *continually varying* direction. Here, as in other cases [VELOCITY; CURVATURE; &c.], we obtain exactness by making definitions drawn from the inexactness of our senses apply, not to the notions which first gave them, but to the final limit towards which we see that we should approach if our senses were made more and more exact, but which, at the same time, we see that we should never reach as long as any inexactness whatsoever remained.

DIRECTOIRE EXECUTIF was the name given to the executive power of the French republic by the constitution of the year 3 (1795), which constitution was framed by the moderate party in the National Convention, or Supreme Legislature of France, after the overthrow of Robespierre and his associates. [COMMITTEE OF PUBLIC SAFETY.] By this constitution the legislative power was entrusted to two councils, one of 500 members, and the other called "des anciens," consisting of 250 members. The election was graduated; every primary or communal assembly chose an elector, and the electors thus chosen assembled in their respective departments to choose the members for the legislature. Certain property qualifications were requisite for an elector. One-third of the councils was to be renewed every two years. The Council of Elders, so called because the members were required to be at least forty years of age, had the power of refusing its assent to any bill that was sent to it by the other council. The executive power was entrusted to five directors chosen by the Council of Elders out of a list of candidates presented by the Council of Five Hundred. One of the five directors was to be changed every year. The directors had the management of the military force, of the finances, and of the home and foreign departments; and they appointed their ministers of state and other public functionaries. They had large salaries, and a national palace, the Luxembourg, for their residence, and a guard. The history of the events which took place during the four years of its existence will be found under BARRAS, and BONAPARTE, NAPOLEON, in the BIOG. DIV.

DIRECTRIX. (*Linea directrix*, a directing line.) This term is applied to any line (straight or curved) which is made a necessary part of the description of any curve, so that the position of the former must be given before that of the latter is known. Thus in the question, "required the curve described by a point in a straight line the two ends of which must be on two fixed straight lines," the two fixed lines are directrices. Custom has sanctioned the special application of this term to lines connected with a few curves, and particularly with the ellipse, hyperbola, parabola, and conchoid of Nicomedes. But in reality, with the exception of the circle, there can be no curve which is without one or more lines to which the name of directrix might be given.

DIRGE, in music, a hymn for the dead, a funereal song. This word is a contraction of *Dirige*, the first word of the antiphona, "Dirige, Domine Deus," chanted in the funeral service of the Roman Catholic Church. The abbreviation seems to have crept into use about the middle of the 16th century.

DISABILITY (Law), an incapacity in a person to inherit lands or enjoy the possession of them, or to take that benefit which otherwise he might have done, or to confer or grant an estate or benefit on or to another. All persons who are disabled from taking an estate or benefit are incapable of granting or conferring one by any act of their own, but many persons who are by law incapable of disposing of property may take it either by inheritance or gift.

Disability is ordinarily said to arise in four ways: By the act of the ancestor; by the act of the party himself; by the act of the law; or by the act of God.

By the act of the ancestor, as where he is attainted of treason or murder, for by attainder his blood is corrupted, and his children are made incapable of inheriting. But by the stat. 3 & 4 Will. IV., c. 106, § 10, this disability is now confined to the inheriting of lands of which the ancestor is possessed at the time of attainder; in all other cases a descent may be traced through him.

By the act of the party himself, as where a person is himself attainted, outlawed, &c., or where, by subsequent dealings with his estate, a person has disabled himself from performing a previous engagement, as where a man covenants to grant a lease of lands to one, and, before he has done so, sells them to another.

By the act of law, as when a man, by the sole act of law without any default of his own, is disabled, as an alien born, &c.

By the act of God, as in cases of idiotcy, lunacy, &c., but this last is properly a disability to grant only, and not to take an estate or benefit —for an idiot or lunatic may take a benefit either by deed or will.

There are also other disabilities known to our law, as infancy, and coverture; but these also are confined to the conferring of interests.

Married women, acting under and in conformity to POWERS, and formerly by fine, but, since the 3 & 4 Will. IV., c. 74, by deed executed under the provisions of that statute, may convey lands; and infants, lunatics, and idiots, being trustees, and not having any beneficial interest in the lands vested in them, are by various statutes enabled to dispose of them under the direction of the Court of Chancery.

Particular disabilities also are created by some statutes; as, for instance, Roman Catholics, by the 10 Geo. IV., c. 7 (the Emancipation Act), are disabled from presenting to a benefice; and foreigners (although naturalised) cannot hold offices, or take grants of land under the crown. [DENIZEN.] (Cowel's 'Interp.;' 'Termes de la Ley.')

DISACRYL. An isomeric modification of ACROLEIN.

DISBUDDING, in horticulture, consists in removing the buds of a tree before they have had time to grow into young branches. It is a species of pruning which has for its object not only training, but also economy with regard to the resources of a tree, in order that there may be a greater supply of nourishment for the development of those buds which are allowed to remain.

If the roots are capable of absorbing a given quantity of nutritive matter for the supply of all the buds upon a stem, and if a number of those buds be removed, it must be evident that those which remain will be able to draw a greater supply of sap and grow more vigorously than they otherwise would have done. This fact has furnished the idea of disbudding.

This kind of pruning has been chiefly applied to peach and nectarine trees, but the same principle will hold good with all others of a similar description, and might be practised upon them if they would repay the labour so expended.

The French gardeners about Montreuil and in the vicinity of Paris have carried this practice to a great extent, and with considerable success.

Several of their methods have been described by Dr. Neill, the secretary of the Caledonian Horticultural Society, in his horticultural tour. In one of them, termed *à la Sieulle*, and invented by Sieulle, gardener at Vaux Praslin, near Paris, the training is made to depend entirely upon the exactness of disbudding.

The peculiarity of Sieulle's method is as follows:—After the stock has been budded, two branches are trained at full length to a trellis or wall: late in autumn or in winter all the buds, with the exception of four on each shoot, are neatly cut out, or disbudded; these four in their turn form shoots in the succeeding summer, which are cut down to about one-third of their length in autumn, and also disbudded in the same manner as the two principal branches of the preceding year. This kind of pruning being always performed prevents a superfluous development of buds and the consequent necessity of cutting them out as branches in the following season. Du Petit Thouars, whose opinions are entitled to much respect, passes a high eulogium upon this system of Sieulle: he says, "by this method the young tree is more quickly brought to fill its place upon the espalier; it is afterwards more easily kept in regular order: many poorer flower-buds are allowed to develop themselves, but the necessity of thinning the fruit is thus in a great measure superseded, and the peaches produced are larger and finer."

Dumoutier's system of disbudding is somewhat different from that of Sieulle. Instead of performing this operation late in the autumn, he defers it until spring, when the buds are unfolded: all those upon the young shoot of the previous year, with the exception of the lowest and the one above the highest blossom, are then carefully removed; of the two which are left, the first is termed the *bourgeon de remplacement* for the next year, and the latter is allowed to remain to draw up the sap for the maturing of the fruit. This method of pruning, as far as disbudding is concerned, is precisely the same as that practised by Seymour, of Carleton Hall, in England.

It must not be thought, however, from this statement that the training of Dumoutier and Seymour is the same, or that their trees assume precisely the same appearance: for example, Dumoutier's branches proceed from two principal arms, Seymour's from one in the centre: in the system of the former, the fruit-bearing branches are on both sides of the old wood; while in that of the latter they are only allowed to grow from the upper sides.

Disbudding in spring is frequently and beneficially practised by many intelligent gardeners, both in England and Scotland, upon English fan-trained peach-trees, with a view to thinning the young wood, taking care to leave enough for the production of fruit in the following year.

When spurious buds can be removed from peach or nectarine trees before development, with the certainty of those succeeding which are allowed to remain, it must be of material consequence, as the latter will not only be better supported, but will also receive a greater quantity of light, so essential to mature and ripen the young wood. Unfortunately, however, Sieulle's plan cannot be practised with any degree of success in England; those buds which are left, and upon which so much dependence is placed, often do not grow; a vacancy is the consequence, and the tree is deformed. The climate of Montreuil is much more favourable to the growth of the peach-tree than that of Britain; and although the winters of Paris are severe, yet the mean degree of summer heat is much greater there than in any part of England; and perhaps the peculiar nature of the soil renders peach-trees much more yielding to art there than in this country.

For these reasons, however useful the plan of disbudding in autumn or winter may be in the gardens of France, it would be improper to practise it to any extent in those of England.

It has, however, been proved that a judicious thinning of the buds after they have been unfolded in spring (when an experienced individual can foresee the strength of those which he is about to leave, and to which he looks for his fruit in the following year), is of great utility.

DISC (*discus*, δίσκος), is used for the face of a circular plate, and frequently for a thin plate of any substance. Thus we speak of the sun's disc (referring to the appearance of the sun), and also of a disc of metal.

DISCIPLINE, MILITARY, the series of duties which are to be performed by military men. It also signifies a conformity to the regulations by which those who serve in the army are governed in all matters relating to the practice of their profession.

DISCLAIMER. A plea by a tenant in any Court of Record in which he disclaims to hold of his lord, which operates as a forfeiture of the lands to the lord upon reasons most apparently feudal. So if the tenant does any act which amounts to a disclaimer, as if he claims a greater estate than was granted to him, or affirms the reversion to be in a stranger, such behaviour amounts to a forfeiture. The writ of right sur disclaimer was the old form in which the lord took advantage of the forfeiture; but as it was decided that the tenant might be treated as a trespasser, and that notice to quit was not necessary, the more convenient action of ejectment came into use, and the proceeding by writ of right was ultimately abolished.

One of the pleadings in a suit in Chancery is also called a disclaimer, as where a defendant, in his answer to the complainant's bill, disclaims all interest in the matter in question. [EQUITY.]

And where an estate is given either by deed or will to a person, he may by deed (which need not be enrolled, or, as it is called, made matter of record) disclaim all interest thereunder.

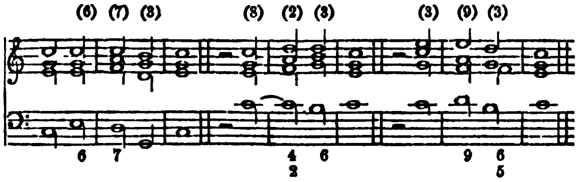
An executor is said to disclaim when he renounces probate of the will of his testator; and where the will contains a devise of lands to the executor, the disclaimer ought to be made by deed to afford evidence, in deducing a title to the lands, of the fact of disclaimer.

DISCONTINUITY (Algebra, &c.). Continuous changes are those which are so made that no two states exist without every possible intermediate state having been in existence between them. Thus the square on a line of 4 inches contains 16 square inches, while that on a line of 5 inches contains 25 square inches; and there is no possible area between 16 and 25 square inches which is not equal to the square described on some line between 4 and 5 inches. That is, if a straight line increase continuously, the square described on it increases continuously.

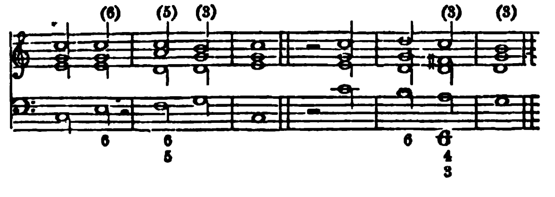
The first introduction of discontinuity arises from the attempt to represent all magnitudes by numbers. Arithmetical symbols cannot represent continuous change of magnitude. If a foot be divided into 2, 3, 4, &c., equal parts, and so on *ad infinitum*, there exist infinite numbers of lengths which will not be represented by any whatsoever of the resulting fractions of a foot. Hence the difficulties of INCOMMENSURABLE magnitudes, which arise from the failure of the attempt to represent flowing or continuous changes by the means of changes which always suppose finite intervals, as in passing from number to number.

But the arithmetical difficulty, being introduced antecedently to the express consideration of discontinuity, is rarely treated as belonging to this subject. In the higher parts of mathematics the necessity for the consideration of discontinuous expressions began with the investigation of partial differential equations. In the introduction of the arbitrary functions which those equations require, discontinuous functions were thought to be admissible by Euler, an opinion which was controverted by D'Alembert, and supported, conclusively, it has always been thought, by Lagrange. It is our own opinion that not only the arbitrary function of a partial equation, but even the arbitrary constant of a common equation, may be allowed to be discontinuous, unless the contrary be a condition of the problem, expressed or implied. By a discontinuous constant, we mean one which preserves one value between certain limits of the value of the variable, which then suddenly changes its value, preserving the new value till the variable attains another limit, and so on.

DISCORD, in music, a sound which, when heard with another, is disagreeable to the ear, unless treated according to the rules of art. Discords are the 2nd, sharp 4th (tritonus), flat 5th (semidiapente), minor or flat 7th, and major or sharp 7th. The ratios of these are 9 : 8, 45 : 32, 64 : 45, 9 : 5, and 15 : 8. The 9th (9 : 4) is also a discord, and though only the octave to the 2nd, is considered in harmony as a very different interval, and treated in a different manner. The 4th (4 : 3) is either discord or concord, according to the manner in which it is accompanied. [CONCORD.] Discords commonly, but not always, are *prepared*, that is, the note which is to become the discord, is first heard as a concord: and their *resolution* is absolutely necessary; that is, the discord must pass into a concord, though the resolution is occasionally retarded. Examples :—



The perfect 5th in the chord of $\frac{6}{5}$, and the 3rd in the chord of $\frac{4}{3}$, are treated, so far as regards resolution, as discords. Examples :—



DISCOUNT, a sum of money deducted from a debt in consideration of its being paid before the usual or stipulated time. The circumstance on which its fairness is founded is, that the creditor, by receiving his money before it becomes due, has the interest of the money during the interval. Consequently, he should only receive so much as, put out to interest during the period in question, would realise the amount of his debt at the time when it would have become due. For instance, 100*l.* is to be paid at the end of three years, what should be paid now, interest being 4 per cent.? Here it is evident that if we divide the whole debt into 112 (or 100 + 3 × 4) parts, 100 of these parts will make the other 12 in three years (at simple interest), whence the payment now due is the 112th part of 10,000*l.*, or 89*l.* 5*s.* 9*d.* The rule is, n being the number of years (or fraction or number and fraction), r the rate per cent., and D the sum due,

$$\text{Present value} = \frac{100\,\mathrm{D}}{100+n\,r};\ \text{discount} = \frac{\mathrm{D}\,n\,r}{100+n\,r}.$$

In practice, it is usual not to find the real discount, but to allow interest on the whole debt in the shape of abatement. Thus it would be considered that, in the preceding example, three years' discount upon 100*l.* at 4 per cent. is 12*l.*, or 88*l.* would be considered as the present value.

In transactions which usually proceed on compound interest, as in valuing leases, annuities, &c., the principle of discount is strictly preserved. The present value in the preceding case is, in its most usual form,

$$\frac{\mathrm{D}}{(1+\rho)^n},\ \text{and the discount } \mathrm{D} - \frac{\mathrm{D}}{(1+\rho)^n};$$

where ρ is the rate per pound (not per cent.: thus it is ·04 for 4 per cent.). But recourse is usually had to the tables of present values which accompany all works on annuities or compound interest. [INTEREST.]

The name of discount is also applied to certain trade allowances upon the nominal prices of goods. In some branches of trade these allowances vary according to the circumstances which affect the markets, and what is called discount is in fact occasioned by fluctuations in prices which it is thought convenient to maintain nominally at unvarying rates. This system is practised in some branches of wholesale haberdashery business, and we have seen a list of prices furnished to his customers by a manufacturer of tools at Sheffield, in which the nominal price of each article was continued the same at which it had stood for many years, while to every different species of tool there was applied a different and a fluctuating rate of discount, this fluctuation constituting in fact a difference of price between one period and another: the rates of discount in this list varied from 5 to 40 per cent. upon the nominal prices of the different articles.

The term discount is also employed to signify other mercantile allowances, such for example, as the abatement of 12 per cent. made upon the balances which underwriters, or insurers of sea risks, receive at the end of the year from the brokers by whom the insurances have been effected. The word discount is further used, in contradistinction to premium, to denote the diminution in value of securities which are sold according to a fixed nominal value, or according to the price they may have originally cost. If, for example, a share in a canal company upon which 100*l.* has been paid is sold in the market for 98*l.*, the value of the share is stated to be at 2 per cent. discount.

There are one or two old difficulties connected with discount. The first is that of the *equation of payments*. Were it not for the difficulty, and its principle, this would not be worth notice. It was at one time the custom of the works on arithmetic to point out, when sums of money are due at different times, at what time the total amount is to be paid at once, in such manner that the receiver may gain, by the sums which are prepaid, what he loses by those which are overdue.

To take a simple case, say it is understood that money makes 5 per cent. simple interest, that 100*l.* is due in three years, and 300*l.* more in seven years. The first rule that was given leads, as the reader knows, to the payment of the whole 400*l.* in six years; by which the interest on 300*l.* paid a year before its time balances that on 100*l.* paid three years after its time. But this, it is said, was not fair; for not interest, but discount, should be allowed for the sum paid before it is due. That is, the 400*l.* paid at the intermediate time should yield 100*l.* due + interest on it since it was due + a sum which put out to interest will make the 300*l.* at the end of the seven years. The rule for this case gives a result 5·9615574 years, instead of six years; which will be found to satisfy the conditions.

In truth, however, it depends entirely upon what the notion of fairness is, whether one rule is better than the other, or whether either will do. And it must be remembered that *simple interest* is a fiction in real business. A creditor cannot demand more than simple interest by law: but it does not therefore follow that because certain money is paid under the name of interest, the receiver will let it lie barren in a bag. But what we say is this: *keep to the fiction* on which both rules are constructed, *let all interest-money remain barren*, and the two rules will come to the same thing in the end. And it is not fair to construct rules on the supposition of simple interest, and then to complain of the inaptitude of those rules to represent the results of real business. Remaining by simple interest, let us see how the receiver will stand at the end of the seven years, upon the different suppositions:—

1. If no equation of payments be made, he will have 100*l.* + four years' interest + 300*l.* just received, 420*l.* in all, with which he is to go on making interest on 400*l.* only.

2. If he receive by the first rule 400*l.* at the end of six years, he will at the end of the seventh year have 420*l.*, of which 400*l.* is to go on at interest as before.

3. If he receive by the second rule he will have at the end of the seventh year (100*l.* + 2·961... years' interest) which he received + 1·038... years' interest which he makes on the 100*l.* (the other part not making interest) + the sum which will in 1·038... years yield 300*l.* (285·19*l.*...) + the interest on this. That is, 420*l.* altogether, of which 20*l.* is interest only: for the last-mentioned item, though gained in the manner of interest, is discount intended to make up a *principal.* Or, if any one will not admit this last distinction, then the most approved rule puts the receiver in a worse position than the old rule.

The fact is, that if equation of payments were ever made, it ought to be supposed that all money, principal and interest, becomes productive money to the receiver from the moment it is received: or compound interest should be supposed. This puts the parties into a state of equity at all times, both during the longest term of debt and after. To show this, suppose that A is due at the end of a years and B at the end of b years, interest being r per pound. To satisfy this debt by a sum A + B paid at x years from this time, the equation to determine x is

$$\mathrm{A}+\mathrm{B}=\mathrm{A}(1+r)^{x-a}+\frac{\mathrm{B}}{(1+r)^{b-x}}$$

and the receiver of the equated sum, m years after its receipt, or $x+m$ years from the present time, will have $(\mathrm{A}+\mathrm{B})\ (1+r)^m$ which is

$$\mathrm{A}(1+r)^{x+m-a}+\mathrm{B}\frac{(1+r)^m}{(1+r)^{b-x}}$$

Or

$$\mathrm{A}(1+r)^{x+m-a}+\mathrm{B}(1+r)^{x+m-b}$$

And this is precisely what he would have had from the payments themselves. And the accumulations or present value of the equated sum are at all times equal to the accumulations or present values of the payments.

There is another remarkable case of the same kind, in which discount at simple interest is compared with notions derived from compound interest, and a rule is consequently said to be false which is, upon its own hypothesis, perfectly true. The value of an interminable annuity, calculated at simple interest, comes out infinitely great: or no sum is large enough to pay it. Now it is clear that 20*l.* will pay an annuity of 1*l.* a year at five per cent. for ever. And this may even be called simple interest, for at the end of a year the interest of the 20*l.* is paid away, and the original principal only remains: so that there is no interest upon interest. But the truth is, that in the construction of all rules at simple interest, the money is arbitrarily divided into two parts, productive and unproductive, and a rule which expressly requires payment to be made from time to time out of the productive part, may produce very different results from another in which the unproductive part is paid away first. Now take the case of an annuity for three years, of 1*l.*, money making r per pound. The ordinary rule gives

$$(1+r)^{-1}+(1+2r)^{-1}+(1+3r)^{-1}$$

At the end of a year, this becomes

$$1+\frac{1+r}{1+2r}+\frac{1+r}{1+3r}$$

The first term 1 is partly principal, partly interest: and 1*l.* of annuity has become due. But the manner in which the rule was framed does not allow us to pay away the $r(1+2r)^{-1}$ and $r(1+3r)^{-1}$, which are never to make interest again, in part of the first year's annuity, but requires that the 1, part of which will make interest, should all be so paid. And, when the productive money is broken in upon before the unproductive is all gone, it is perfectly true that no sum is large enough to pay a perpetual annuity: and, if this be done, not only may the rule for a perpetual annuity be objected to, but with as much justice that for a finite term of years. For instance, at 10 per cent., an annuity of 1*l.* for five years is worth, according to the usual simple-interest suppositions, 3·89261*l.* A year's interest is ·389261*l.*; let this all be paid away, and the balance of 1*l.* made up out of the principal, and so on, and it will be found that there is a sum in hand at the end of the ten years: in fact 3·79079*l.* will in this way be enough to meet all demands. But the manner in which the rule is constructed supposes the annual demands to be made up out of principal and interest in the following way, the sums before the lines showing how the pound yearly accruing due is raised, partly out of principal, partly out of interest:—

	Principal.		Interest.	
	3·89261		·38926	
Pay	·90909	+	·09091	= £1.
	2·98352		·29835	
			·29835	
Pay	·83333	+	·16667	= £1.
	2·15019		·43003	
			·21502	
Pay	·76923	+	·23077	= £1.
	1·38096		·41428	
			·13810	
Pay	·71429	+	·28571	= £1.
	·66667		·26667	
			·06667	
Pay	·66667	+	·33333	= £1.
	·00000		·00001	

While if interest were made to go as far as it could, we should have

3·89261		
·38926		
3·28187	after paying £1.	
·32819		
2·61006	"	"
·26101		
1·87107	"	"
·18711		
1·05818	"	"
·10582		
·16400	"	"

to that there would remain ·164*l.*

The truth is, that the rule for annuities by discounting at simple interest *is* wrong except upon the condition that principal and interest are to be rated in a specified way (which those who understand the formula will easily collect) to meet the accruing demands. And moreover, when interest is to be all disposed of first, before any principal is touched, *the rules for simple and compound interest are identical.*

It is, however, necessary to distinguish between true discount and the discount of commerce. When a bill of exchange for 100*l.*, having three months to run, is presented by the holder for discount; the discounter calculates the simple interest on 100*l.* for three months, with three days of grace added, deducts this from the amount of the bill and pays over the difference to the holder. Thus it will be found on consideration, that the discounter always obtains something more than the usual and current rate of interest for the money that he thus employs. Bills of exchange, on which are the best names, are discounted on the lowest or most liberal terms; because the rate of discount must, of course, rise as the character of the parties to the bill appears to be lower in point of solvency: the rate of discount also has a tendency to rise, when money is scarce, which tendency not unfrequently grows into an effect almost independently of the character of the paper offered for discount. [See examples under BANK; where also see Re-discount, vol. i., col. 858. The usual course of the Bank of England in regard to discounting will be found fully explained in the article BANK, BANKER, BANKING] Also, under other circumstances, when confidence is interrupted, the discounting of bills is only done at very high rates, and in some extreme cases it is altogether refused by the ordinary bill discounters. ('Rep. of Committee on Bank Acts' 1858, p. viii.)

Discount is also said to take place on merchandise, when a buyer having agreed with the seller to pay for the goods so much on such a day which is to come, before that day arrives finds that he is in cash sufficiently to pay, and claims and gets from the seller a deduction from the price so settled, in consideration of his anticipating the day of payment. This discount is in practice made at a rate which usually exceeds the current interest of the day.

DISCOVERY IN LAW. [EQUITY.]

DISCOVERY. [INVENTION AND DISCOVERY.]

DISCUS (*δίσκος, discos*), a quoit of stone, brass, or iron, 10 or 12 inches in diameter, with which the Greeks and Romans diverted themselves in the public games. The discus, when perforated like our modern quoit, was thrown by the help of a thong, put through the middle of it. It was at other times of a solid piece, and was then hurled directly from the hand. The object was to throw it to as great a distance as possible. This last method is illustrated by the celebrated statue of the Discobolus, or quoit thrower, attributed to Myron. Of this famous statue several ancient copies are in existence, one of the very finest being that in the British Museum engraved below. The figure is represented in action at the precise moment of delivering the discus. Ovid ('Metam.,' li. x., v. 175) and Statius ('Theb.,' vi., v. 646) have both described the diversion of the discus; see also Petri Fabri, 'Agonisticon, sive de Re Athletica, Ludisque Veterum,' 4to, li. ii., c. i., Lugd. 1595.

[The Discobolus, from the statue in the British Museum.]

The term discus was likewise applied to circular shields or bucklers, of a large size, placed in the temples, on which great actions were represented, or the names inscribed of the ephebi, that is of the young men, who had devoted themselves to the service of their country. One of these circular shields is in the Townley Collection of the British Museum, containing the names of the ephebi of Athens, under Alcamenes, when he held the office of cosmetes. It was found in a church at Athens in 1748, by Dr. Askew, who was informed that it had been brought there from the Parthenon. Such too was the shield of Scipio Africanus, found in the Rhone in 1656, engraved in Spon's 'Miscellanea Eruditæ Antiquitatis,' p. 152, edit. 1685. Anacreon has an ode on a disk of silver, representing Aphrodite rising from the sea: Od. 51, Εἰς Δίσκον ἔχοντα Ἀφροδίτην. See likewise Montfaucon, 'Supplem. de l'Ant. Expliq.,' liv. iii. p. 64. Discs sculptured on both sides, with heads, bacchanal subjects, &c., were also suspended by chains between the columns of Roman mansions and theatres. Several specimens of these *clypea*, as they were called, may be seen in the Græco-Roman Basement Room of the British Museum.

DIS-DIAPASON, the name given by the Greeks to a scale of two octaves. [DIAPASON.]

DISLOCATION. Various parts of the body are liable to be displaced by the direct application of violence or by more gradual causes. But the term *dislocation* is commonly appropriated to displacements occurring about the joints. In this sense it is nearly synonymous with *luxation*, but not entirely; for the latter term carries with it more of the idea of external force, and it is not quite so generally applied. It is usual, for instance, to speak of the *dislocation*, not the *luxation*, of the internal cartilage of the knee; and the latter term is seldom if ever used in describing the displacements of the small bones of the wrist or instep, or of single vertebræ.

The injuries classed under this title may be effected by external violence, or by the undue contraction of muscles, or by both of these causes combined; and they result in some instances from disease within the joints themselves, by which their ligaments are weakened or destroyed, and their sockets rendered insecure by ulceration and other gradual changes.

When, by the protrusion of the bone through the skin, or otherwise, the dislocation is complicated with an external wound exposing the cavity of the joint, it is said to be *compound*; and, as in the parallel case of fracture, this aggravation of the injury is very serious, and the most skilful management is required to save the life or limb, where the injury happens to one of the larger joints.

The particular dislocation takes its name either from the joint itself or from the farthest bone; and various terms are added to indicate the direction of the displacement, or the new situation of the head of the bone. Thus, the most common form of the accident at the hip is called "a dislocation of the head of the *femur* (thigh-bone) *backwards* upon the *dorsum ilii*" (flat part of the haunch-bone).

Any bone may be displaced in any direction, but the accident happens most frequently in those joints and directions in which the extent of motion is the greatest. Thus the most common dislocation is that of the shoulder, which is the most movable joint; and its most frequent variety is that in which the head of the *humerus* (or bone of the upper arm) is drawn downwards into the *axilla* (or arm-pit) by the sudden contraction of certain strong muscles. This happens when the arm is raised to the utmost, as in reaching to close a window; that is when it has moved through an angle of 180 degrees from its natural position. The most usual dislocation of the hip is that, already mentioned, on the *dorsum ilii*, for the same reason. It is generally produced by sudden pressure or a blow on the knee when the thigh is bent upon the abdomen; the head of the *femur* is thus driven backwards from the socket, and is then drawn farther back and upwards by the powerful muscles of the buttock.

The jaw is sometimes thrown out of joint by the mere act of yawning; and that accident happened to a gentleman known to the writer in opening his mouth to make the usual response at church. The word was cut short at the first syllable; for in such cases the chin suddenly drops and is thrown forward, and it is impossible by any effort to shut the mouth. This distressing but irresistibly ludicrous accident may be relieved immediately by any bystander wrapping a napkin round his thumbs and placing them firmly against the back teeth, so as to press them downwards, while with the fingers and palms the chin is steadily raised and pushed backwards. But the operator should be on the alert to withdraw his hands the moment the jaw snaps back into its place, or he may receive a very unpleasant intimation of the success of his efforts.

It will be easily seen from these instances how important a part is played by the muscles in determining both the occurrence and direction of these accidents. Hence arises in part their infrequency, often wondered at, during infancy and childhood; for though the flexible joints of the young have a greater extent of motion than those of the adult, their muscular power is not only weaker as compared with the strength of their ligaments, but is much more tardily thrown into action, as may be observed in their tottering gait. The fragility of their bones is another cause of this infrequency, by rendering them more liable to be broken than displaced by external violence. The only dislocation that is at all common in children is that of the hip, which is the consequence of scrofulous ulceration of the ligaments and the socket, and of the ball-shaped head of the femur within it.

The reader will be prepared by what has been said to learn that the spasmodic and violent contraction of the muscles consequent upon these displacements is the chief or only obstacle to their reduction.

This object is effected by a process technically called *extension*, consisting in the application of force in a proper direction, and steadily kept up till the muscles are fatigued. The head of the bone is thus drawn down a little below the level of the joint; and being lifted over the edge of the socket, slips easily into its place upon slightly relaxing the extending force. This force is often required to be very considerable, and in such cases it is customary to make use of a block of pullies, the bone which contains the socket having been first securely fixed to a staple in the wall by proper bandages. Luxation of the hip is here supposed; for the other joints are so inferior to that in strength that their displacements may generally be reduced by less imposing means. It is sometimes necessary to favour the relaxation of the muscles by emetics, warm baths, and bleeding, and it is reckoned a point of good management to call off the attention of the patient during the extension by annoying him with questions and even exciting him to anger.

Almost all dislocations arising from accident may be reduced in this way, and the joint rendered nearly or quite as perfect as before: but this can only be done on condition of perfect rest during a period sufficient for the firm union of the ruptured ligaments; for if this precaution be not strictly observed, and the ligaments are suffered to be stretched by motion while the uniting substance is soft and extensible, the accident is ever afterwards liable to recur. No time should be lost in seeking assistance, for the swelling that comes on soon renders the nature of the accident obscure, and the reduction extremely difficult and painful. When a joint has been unreduced for a certain time, which varies with the particular joint, and with the bodily strength of the individual—the weaker having the advantage in this respect—it is unwise to make any attempt at reduction. The parts have now become consolidated and adapted to their new situation, and either the limb is permanently fixed or a new joint is under process of formation. In the latter case the substitute is often better than might be expected; and as this curious provision of nature cannot be improved upon by art, it is better to leave it alone.

The most dangerous dislocations are those of the vertebræ or bones of the spine, because in that case all the parts of the body below the injury are paralysed. But the vertebræ are so curiously locked together, and have singly so little motion, and are at the same time so well supported by ligaments and muscles, that they are seldom dislocated unless by a force sufficient to break as well as to displace them. Such an injury is almost always fatal, and instantly so in general when it takes place above the origin of the nerves of respiration, that is, above the fourth vertebræ of the neck. The object of the executioner in hanging a criminal is to produce this effect, but he more often fails than succeeds.

DISPART, the difference between the semidiameter of the base ring, at the breech of a gun, and that of the ring at the swell of the muzzle.

On account of the dispart, the line of aim or line of metal, which is in a plane passing through the axis of the gun, always makes a small angle with the axis; so that the elevation of the latter above the horizon is greater than that of the line of aim: an allowance for the dispart is consequently necessary in determining the commencement of the graduations on the tangent scale, by which the required elevation is given to the gun.

The dispart, therefore, subtends, at the base of the gun, an angle equal to that which, in a vertical plane passing through the axis of the bore, would be contained between that axis and a line (called the *line of metal*) drawn from the circumference of the base to that of the muzzle. In a 24-pounder gun, nine feet long for example, the dispart is equal to 2·735 inches, and the angle subtended by it is equal to 27′ nearly; allowance must consequently be made for this value in pointing the gun by the line of metal.

In order to place the axis of the bore at any angle with a horizontal plane, a "tangent scale" is employed [ORDNANCE]; and in determining the graduations of this scale, it is manifest that the length of the part raised out of the groove in the base of the gun should (the length of the gun being considered as the radius) be equal to the tangent of the difference between the number of degrees in the proposed angle of elevation and the angle subtended by the dispart; in order that, on lowering the base of the gun till a line joining the top of the scale and the top of the muzzle is parallel to the horizon (which may be determined by a spirit-level on a rod laid from one of those points to the other), the axis of the bore may be correctly elevated. Thus, in the gun above mentioned, for an elevation of one degree, the scale being raised up till the division marked 1° coincides with the top of the base ring, the part raised should be equal to the tangent of 33′ only; for an elevation of two degrees, the part raised should be equal to the tangent of 1° 33′; and so on.

In some guns, however, such as the 8″ and 10″ shell guns, the 68-pounders, and some 32-pounders, where the line of metal would give a large dispart, the inconvenience arising therefrom is avoided by a dispart sight, a raised sight on the centre of the gun between the trunnions which is of such a height that the line joining its top and the notch in the base ring is parallel to the axis of the gun.

DISPENSARY, an institution supported by voluntary contributions for the supply of the poor with medical and surgical advice, and with medicines gratuitously. Institutions of this kind are of very recent origin. They differ from hospitals in this, that the sick, when too ill to attend personally at the institution, are sometimes visited at their own homes by the medical officers of the charity. Each dispensary indeed is restricted to a certain district, beyond the limits of which the patients are not visited at their own houses. To every dispensary there are always attached one, and sometimes two physicians; one surgeon, and often a consulting surgeon, and a resident medical officer who dispenses the medicines prescribed by the physicians and surgeons. Every subscriber to the institution who pays annually a certain sum is called a governor, who is entitled to have at least one patient always on the books; a person who subscribes a larger amount in one sum is called a life-governor, who may have two or more patients on the list. The medicines, which are commonly purchased in considerable quantities at a time and at wholesale prices, are dispensed in inexpensive forms, and in this manner the extent of the relief afforded is great, while the cost is trifling. No other kind of charity affords so much real assistance at so small an expense, and perhaps fewer objections apply to this than to any other mode of giving eleemosynary aid to the poor. Its peculiar excellence is that it enables the sick poor to obtain advice on the very first day of their ailment, and they are thus frequently enabled to avoid a protracted illness. Even the great metropolitan hospitals are often so full that urgent cases are constantly obliged to wait days and even weeks before admission can be obtained; but by means of the dispensary poor families, and even the heads of such families in regular employment, may procure medical and surgical assistance without leaving their occupation even for a day. It would be a great improvement in the principle of these institutions if some contribution towards their support on the part of the poor themselves were required to entitle them to avail themselves of the advantages which they afford. This would remove the only objection that can be urged against such establishments, and would enable the independent labourer, without asking charity, to procure the best advice for his sick family at a much cheaper rate than he can possibly do at present.

At the same time it should be recollected, that these institutions are exposed to much abuse. The attendance of the medical officers being gratuitous, there is a great inducement to a hasty and insufficient attendance on the sick. On the other hand, a great number of persons obtain relief at these institutions who could well afford to pay for medical attendance. The only check upon these abuses would be the payment of the medical officers for their services, who should be responsible for the proper performance of their duties to the governors. The governor too ought not to use these institutions for the benefit of his poor relations or servants, but to take care that only those who cannot afford to pay are recommended for relief. This was the principle advocated by Mr. Smith of Southam, in his self-supporting dispensaries. But unfortunately it met with little support or encouragement. Many of the clubs, or societies, particularly among the Jews, are on the independent plan.

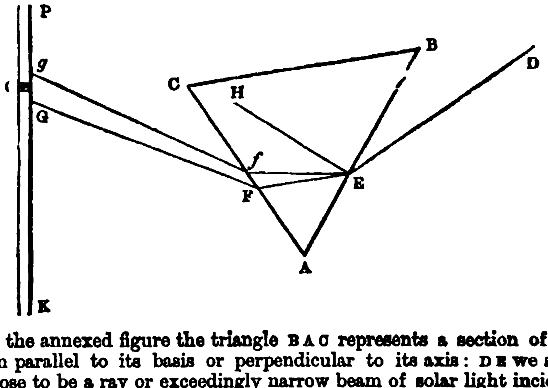
DISPENSATION. The only kind of dispensation now used is that by which the bishop licenses a clergyman within his jurisdiction to hold two or more benefices, to reside out of his parish, or dispenses with some other particular of his strict duty.

Dispensations formed a great source of the revenue of the court of Rome; for the pope's dispensations prevailed against the law of the country in many if not most instances, indeed in all of an ecclesiastical nature. This abuse was abolished in England by the statute 25 Henry VIII., c. 21; and the power of the pope to grant dispensations, not contrary to the law of God, was granted to the archbishop of Canterbury under certain restrictions. It is under this general transference of papal jurisdiction that *Lambeth degrees* are granted. It is hardly necessary to state, however, that this dispensary power is never exercised in civil cases, and but in a few cases of purely ecclesiastical cognisance, and in those the usage has become the law rather than the exception. The right of the archbishop to grant special licences of marriage, has been expressly recognised by the legislature.

Formerly also the crown claimed a dispensing power, by which it could exempt a person from the ordinary liabilities to the laws of the realm; the limits of which were never exactly defined. It was expressly abolished by the Bill of Rights on the accession of William and Mary.

DISPERSION. Light, as we receive it from the sun or from other original sources, as a star, a fire, a candle, &c., appears to the senses as a simple undecomposable element by the intrumentality of which objects are perceived; and as for the peculiar colours of bodies, we naturally consider them, according to our early impressions, as belonging to the bodies themselves, or inherent in them. We are partly undeceived in this view by the changing colours of birds' feathers, soap-bubbles, &c.; but we are enabled to trace the immediate cause of the colours of bodies, whether permanent or transient, by the analysis of light furnished by the well-known experiments of the glass prism.

The triangular prism used for this purpose is a solid, terminated by two equal and exactly similar triangles, and having besides three plane faces of a rectangular form, contained by the sides of the triangles and by right lines or edges joining corresponding angles of the two triangular bases above-mentioned; and any imaginary right line within it parallel to these edges around which the prism is capable of revolving is called the *axis of the prism*.



In the annexed figure the triangle B A C represents a section of the prism parallel to its basis or perpendicular to its axis: D E we shall suppose to be a ray or exceedingly narrow beam of solar light incident from *vacuum* or air on the prism at E; this ray of white light enters the prism at that point, and having undergone refraction by the dense medium of the glass, no longer proceeds as a simple ray E F, but is *dispersed* or divided into various rays of different colours over the space represented in the figure by *f* E F, and emerging at *f*, F from the prism, undergoes another refraction, such that the portion *fg* of the ray proceeding from *f* is still more refracted than the portion F G from F; let now this dispersed beam *gf* F G be intercepted by a screen or wall P K, from which extraneous light is as much as possible excluded, we shall then find the elongated space G *g* brilliantly painted over with tints passing gradually and insensibly from deep red to an attenuated violet, in the following order, as described by Newton, and since very generally concurred in,—red, orange, yellow, green, blue, indigo, violet. This experiment, which first opens the analysis of light, is easily made by letting a beam of sunlight pass through a small circular hole in a shutter, in a darkened room, on a glass prism such as above described, the refracted and dispersed beam being received on the opposite wall, ceiling, or floor, according to the position of the prism.

When the image of the sun, or a star, candle, &c., is thus formed by admission through a small hole, and the refraction of the prism, the coloured space G *g*, which has the same angular breadth in a direction parallel to the axis of the prism as it would have had if the prism were removed and the light received directly on the screen at the same distance from the place of the prism (the screen being in both cases supposed to be held perpendicularly to the incident light), but which is considerably elongated in the perpendicular direction, is called the *spectrum ;* and that angle of the prism B A C the sides containing which B A, A C, have been traversed by the ray D E F G, is called the *refracting* angle of the prism.

Suppose, now, that a small orifice, O, is made in the screen at some point of the spectrum, so that rays of any particular colour, green for example, may be transmitted through it; and let the transmitted portion be again submitted to refraction through another prism, this beam being supposed very small, to ensure its purity or near uniformity of colour. It will not, after refraction, be again decomposed, or undergo any alteration of colour; but if the first prism be turned round its axis, which will cause different colours in succession to fall on O, while the direction of the ray incident on the second prism remains unchanged, being that of a line joining O with the first prism, it will be found that as we pass from the red to the violet the ray will be more and more bent round by the refraction of the second prism. This shows that light incident on the first prism, when once decomposed into homogeneous elements by refraction, is then, at least by refraction, not further decomposable, but each element retains its own colour and its own *refrangibility*, or disposition to be bent by refraction.

This experiment will not perfectly succeed with sun-light as above described, because however small be the hole in the window the incident beam will not be a mere ray, on account of the finite angular diameter of the sun, but a cone of very sensible angle, so that the first spectrum will be *impure*, from the finite size and consequent overlapping of the coloured circles corresponding to the elementary kinds of light. It might be rendered pure, but at great expense of light, by limiting the beam by a screen with a small hole placed at some distance from the first hole. But it is far better, according to the method first described by Newton, to combine the prism (which in this case must be placed at a considerable distance from the hole in the window) with a convex lens, and receive the spectrum on a screen placed at the focus of the lens conjugate to the hole in the window. The lens alone collects into a point the divergent pencil of rays of any one kind; the prism alone bends it round as a whole, but differently for the different kinds, without (at least in the position of minimum deviation) affecting the divergency; and the two combined will give a *pure* and brilliant spectrum, but very narrow. To obtain an equally pure and brilliant spectrum, but of considerable breadth, we have only to replace the hole by a narrow aperture parallel to the axis of the prism. If our object be merely to see a pure spectrum, without placing objects in it, we may replace the lens and the screen by the eye and the retina, that is, merely view, through a prism applied to the eye, a slit transmitting light. In this way very pleasing and instructive experiments may easily be made on the action of absorbing media (such as coloured glasses, &c.) on light. Instead of the naked eye, a telescope may be employed; and in this way accurate measures may be taken, supposing the telescope to be properly mounted, and furnished with cross wires.

We have seen that compound light, the sun's for example, may be decomposed into its homogeneous constituent rays by refraction through a transparent prism. Conversely it may be recompounded into light similar to the original, merely by making the rays thus separated, by another refraction to occupy the same place. This may be effected by placing a prism of exactly similar material and form to that already used, with its refracting angle turned in a direction opposite to that of the former, so that the near faces of both prisms may be parallel; for the rays entering the second prism are in the same condition as if we supposed their direction inverted, that they may repass through the first; and therefore they emerge in a similar compound ray with the original, which may also be easily confirmed by experiment.

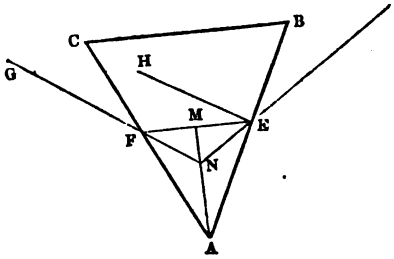
The rays issuing from the second face of the refracting prism, may also be collected by means of a large convex lens, placed at a considerable distance from the prism. If the rays after passing through the lens be received on a screen of white paper, which is first held close to the lens and then moved away, the spectrum will contract in width, until at the focus conjugate to the prism the colours disappear, the original compound white light being reproduced, after which the colours reappear in the reverse order.

The prismatic analysis of light, together with the phenomena relative to the transmission and absorption of light, enabled Newton to conclude that the colours of natural bodies are not inherent qualities of those bodies, but depend on their powers of reflecting, transmitting, or absorbing the rays of some colours more than others from the compound light incident on them; for all bodies placed in homogeneous light of any colour appear themselves to be of that colour, though they are most luminous (making allowance for the different intensity of different parts of the spectrum) when placed in that coloured light which they reflect most copiously. Hence also arise the different colours of coloured liquids or glasses. [ABSORPTION.]

Many of the prismatic colours may be imitated by mixing colours taken, as they lie in the spectrum, of greater and less refrangibility, as orange from red and yellow, &c., but such compound colours are not identical with the homogeneous light of the same colour, being immediately decomposed when viewed through a prism.

If the original prism B A C be turned gradually round its axis, presenting always to the incident light the same refracting angle A, the spectrum G *g* may be made to descend towards K, but after arriving at a certain point where the deviation, that is the inclination of D E produced to F G, is a minimum, it then re-ascends, and it is usual to make the chromatic experiments in this definite position of minimum deviation. This occurs when the position of the prism is such that the angles of incidence and emergence, or their complements D E B, G F C, are equal; for when the moving point G has reached its lowest place, it is for a moment in the condition of a fixed point like the point D, through which we may suppose the incident beam admitted; hence rays proceeding from D, notwithstanding a small variation of incidence arising from the rotation of the prism, reach G, as if it were a fixed point; and since in dioptrics it is of no consequence to the *path* in what direction we suppose the rays to move, it follows that rays proceeding from G, notwithstanding a small alteration of the angle C F G, would arrive at the fixed point or orifice D; and consequently the *data* for the determination of the angles D E B, G F C, in the position of minimum deviation, are precisely the same, and therefore these angles must then be equal.

This being premised, the following easy calculation will give the necessary angle of incidence to produce a minimum deviation.



Since the angles of incidence and emergence are equal, the angles formed by the interior ray E F with both sides of the prism are equal, or the triangle A E F is an isosceles; let 2α be the refracting angle of the prism, then drawing A M perpendicular to E F, we have $\angle EAM = \alpha$, which being the complement of A E M, is necessarily the angle of refraction; if, therefore, μ be the index of refraction for rays of any given colour, the angle of incidence P, corresponding to a minimum deviation, is given by the equation,

$$\text{Sin } P = \mu \sin \alpha \quad . \; . \; . \; . \quad (1)$$

Also the deviation of the ray at either refraction is equal to the excess of P, the angle of incidence, over the angle of refraction, which in this case is equal to α. If then D be the whole deviation, or the angle between the directions of D E and F G, and $i = 2\alpha$, the whole angle of the prism, we get from (1)

$$\text{Sin } \frac{D + i}{2} = \mu \text{ Sin } \frac{i}{2} \quad . \; . \; . \; . \quad (2)$$

The angles i and D, and consequently the value of μ, admit of very exact determination by using a telescope properly mounted, provided we can find in the spectrum an object sufficiently precise to fix on. The transition from one colour into another is far too gradual to allow us to fix on the limit which separates them; but fortunately we have been put in possession of perfectly definite standard objects by the beautiful discovery made by Wollaston and Fraunhofer of the existence of dark spaces, narrow bands transverse to the length of the spectrum, and now generally designated Fraunhofer's lines.

These bands are best observable by forming the spectrum of a luminous line instead of a point, by means of a prism of great purity, and viewing it through a telescope of good magnifying power, though some of them may, when carefully pointed out, be recognised by the unassisted eye, and after one recognition are in future easily found; and for naked eye observations a prism of moderate purity will suffice. They are spaces totally deficient of light, of very unequal width, and exceedingly numerous; it is also to be remarked that these bands, always the same in number and relative position for the same light, are different, or altogether wanting, when the source of light is varied. Thus sun-light, moon-light, planet-light, sky-light, derived from a common source, have the same lines, but several of the fixed stars have dark lines of their own, while artificial lights rarely if ever exhibit dark lines, but frequently show *bright* lines, of which the light of the electric spark is almost wholly made up.

In the formula (2) suppose the angle of the prism i, and consequently the deviation D, to be very small, then

$$D=(\mu-1)\,i, \quad . \; . \; . \; . \quad (3)$$

a formula which may be readily shown to remain true so long as the angle of incidence is small, even though the angles of incidence and emergence should no longer be equal.

Suppose now that while D, μ relate to rays of mean refrangibility they become D_1, μ_1 and D_2, μ_2 for two definite kinds of rays chosen as nearly as may be at the red and violet extremities of the spectrum. The formula (3) shows that the *difference* of deviation D_2-D_1, or δD, that is the length of the spectrum, is expressed by $(\mu_2-\mu_1)\,i$ or $\delta\mu.i$. The ratio of the difference of deviation $\delta\mu.i$ to the mean deviation $(\mu-1)\,i$, or $\frac{\delta\mu}{\mu-1}$, depends (for given selected rays) only on the nature of the substance of which the prism is made, and is called the *dispersive power* of the substance.

Newton supposed that all substances disperse light in the same proportion as they refract it, and concluded that in refracting telescopes it was impossible to get rid of the defects arising from the chromatic dispersion of the object glass. Mr. Hall was the first to point out Newton's mistake, and to apply the fact of the difference of dispersive power of substances to the construction of an achromatic telescope (Herschel's 'Light,' art. 425); but the discovery fell into oblivion, and it was not until after the fact had been rediscovered by Dollond, and reapplied to the same object, that the achromatic telescope came into general use. The mode in which the compensation is effected by the use of two lenses may be readily understood from the following considerations.

Imagine a single ray to be transmitted through a convex lens in a direction nearly parallel to its axis, but at a good distance from its centre. If tangent planes be drawn at the two points where the ray cuts the surfaces, the refraction of this single ray will be the same as if the lens were replaced by a slender wedge or prism of the same material bounded by those tangent planes. Consequently the ray will be not only deflected as a whole, but "dispersed." If now we consider all the rays emanating from a distant point in the axis of the lens we readily see that the violet rays will be brought to a point or focus in the axis of the lens sooner than the green, the green than the red, &c. At no one distance will all the rays be brought to a focus together, and consequently the image will be confused.

Suppose now we have two slender prisms, composed of different materials, in contact with one another or nearly so, with their angles i, i' turned in contrary directions; and let a ray of white light be incident nearly perpendicularly upon the system. The deviations produced by the two prisms being $(\mu-1)\,i$ and $(\mu'-1)\,i'$, the whole deviation will be

$$(\mu-1)\,i-(\mu'-1)\,i', \quad . \; . \; . \; . \quad (3)$$

while the *difference* of deviation of the red and violet rays will be

$$\delta\mu\,.\,i-\delta\mu'\,.\,i' \quad . \; . \; . \; . \quad (4)$$

Unless therefore $\delta\mu : \mu-1 :: \delta\mu' : \mu'-1$, that is unless the dispersive powers of the two substances are the same, the difference of deviation may be destroyed without at the same time destroying the common deviation of the two kinds of rays. The outstanding deviation will be in the direction of that produced by the prism of smaller dispersive power.

Suppose now that a compound lens is formed consisting of a convex and concave of substances differing in dispersive power; and imagine the course of a ray incident towards the edge in a direction nearly parallel to the axis. By drawing tangent planes as before, the lenses may, as regards the course of this single ray, be replaced by a pair of prisms turned in contrary directions. The small chromatic variations of the points of incidence, and consequently of the angles of the prisms, arising from the dispersion of the ray during its passage through the lenses, may be altogether neglected. Now the deviations being on the one hand as $(\mu-1)i$ to $(\mu'-1)\,i'$, and on the other inversely as the focal lengths F, F' for parallel rays, we have $(\mu-1)\,F\,.i=(\mu'-1)\,F'.i$, and substituting in (4) equated to zero we find

$$\frac{\mu}{\mu-1}\,\frac{1}{F}=\frac{\delta\mu'}{\mu'-1}\,\frac{1}{F'},$$

or in order that the dispersion may be corrected, the focal lengths must be as the dispersive powers.

The dispersive power of substance is most accurately determined by forming the substance into a prism of considerable angle (supposing it sufficiently homogeneous), and determining, as before explained, the refractive indices for two properly selected and perfectly definite points of the spectrum, such as two fixed lines. The ratio of the dispersive powers of two substances, which is all that is required for the construction of an achromatic object-glass, may, however, be determined by different methods of compensation. One of the simplest, at least in theory, which has been much employed by Dollond and practical opticians up to the present day, consists in forming two prisms of the substances with small angles, and altering by trial the angle of one of the prisms until an object seen through both appears as free as possible from fringes of colour, when the dispersive powers are inversely as the deviations produced by the two prisms respectively.

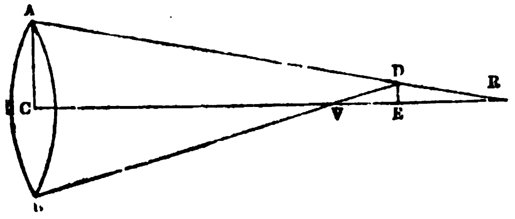
When different substances are formed into slender prisms through which light passes nearly perpendicularly, not only does the separation of the extreme rays bear to the mean deviation a different ratio in the different substances, but the ratio of the angular extent of one portion of the spectrum to that of another portion changes from substance to substance. Thus if three definite points, (such as three fixed lines,) be taken in the red, the green, and the violet, the ratio of the separation of the violet from the green to that of the green from the red will be greater in flint glass than in crown. This want of proportionality is termed the *irrationality of dispersion*, and the outstanding spectrum formed when two prisms as nearly as possible compensate each other, which is coloured green on one side and purple (from a mixture of red and blue) on the other, is called a *secondary spectrum*. This irrationality prevents the compensation in the case of a double object glass from being perfect, and constitutes one of the chief obstacles to the perfection of large refracting telescopes.

The rainbow is a beautiful natural exhibition of the dispersion of light into spectral colours. [RAINBOW.]

Two simple propositions relative to the effect of chromatic dispersion in a single lens are here subjoined.

To find the longitudinal chromatic aberration of a lens, or the interval on the axis between the foci of extreme red and violet rays.

Let the red rays converge to the point R, and the violet to the point V in the axis.



Let f, F be respectively the focal distances for the given system of rays, and a parallel system; then the fundamental equations for lenses (neglecting their thickness), give $\frac{1}{f}-\frac{1}{F}=$ constant, since the rays of all colours in the compound incident beam have a common origin; now differentiate relative to μ, the variable index of refraction: hence,

$$\frac{df}{d\mu}=\frac{f^2}{F^2}\,.\,\frac{dF}{d\mu};$$

but since F is proportional to $\mu-1$, therefore $\frac{1}{F}\,.\,\frac{dF}{d\mu}=\frac{1}{\mu-1}$; and if $\delta\mu$ denote the total variation of μ from extreme red to violet, and δf the corresponding variation of f, or longitudinal aberration, and finally h, the dispersive power of the medium, we have

$$\delta f=\frac{df}{d\mu}\,.\,\delta\mu=\frac{f^2}{F}\,.\,\frac{\delta\mu}{\mu-1}=h\,.\,\frac{f^2}{F}.$$

To find, in the same case, the radius of the circle of least chromatic dispersion.

By referring to the same figure, we may observe that the foci R. V are respectively the vertices of red and violet conical surfaces, having the lens as a common base. Let these surfaces intersect in a circle, of which the radius is D E; then it is plain that all the intermediate coloured rays pass through this circle. It is therefore that of least dispersion:

The preceding figure representing a plane section of the whole system taken through the axis, it is obvious that, from the smallness of R V relative to C R, the angles C V B, C R A are sensibly equal, or the triangle V R D is exceedingly nearly isosceles, and therefore D E bisects V R, or $ER=\frac{\delta f}{2}$ and $DE=ER\,.\,\frac{CA}{CR}=\frac{h}{2}\,.\,\frac{f}{F}\,.\,CA$, and for parallel incident rays $DE=\frac{h}{2}\,.\,CA$.

DISPOSITION, in the law of Scotland, is the name given to an instrument, or as it would be termed in England, deed poll, by which a party solemnly makes over to another real property. It may be used as a title to moveables alone, but it is in the law of real property that it is of most frequent use and of highest importance, the conveyance of moveables being usually by assignation or assignment. When a new feu or fief is created, it is by charter or contract of feu, containing a disposition in itself, or disposition in feu; but when a feu, fief, or estate is transferred from one holder to another it is by Disposition, in which all the conditions on which the property is to change hands are set forth. Being given to the disponee, it is in his hands a personal obligation by the disponer to give him a full title, and contains the warrants for getting the title made real by registration, and by obtaining the superior's sanction to the new investiture. As heritable property cannot be bequeathed by testament in Scotland

[Will], the usual form of family settlements in which such property is disposed of is the disposition.

DISSECTION. The art of separating the parts of organised bodies in such a manner as to display their structure. It is an art equally applicable to both divisions of the organic kingdom, and indispensable alike to the discovery of the structure of plants and animals. The grounds on which, for the well-being of the community, every facility should be afforded to the cultivation of this art, as far as regards human dissection, have been already stated. [Anatomy Act.] It is satisfactory to observe that the prejudices which formerly obstructed this practice are rapidly disappearing, and that even the most uneducated are beginning to appreciate its great importance and its signal utility.

DISSEISIN. [Seisin.]

DISSENTERS, the general name for the various Protestant religious sects in this country that disagree in doctrine, discipline, or mode of worship with the Established Church. The Jews and Roman Catholics are not commonly called dissenters. The origin of Protestant dissent from the Church of England is usually traced back to the year 1548, in the reign of Edward VI., when a controversy arose among the adherents of the new Reformation in consequence of the excellent Hooper (afterwards the martyr) scrupling to be consecrated as bishop of Gloucester in the customary canonical habit, which he deemed objectionable as a relic of Romanism. Hooper eventually received consecration without being attired in canonicals. At this time the two parties received the names of Conformists and Nonconformists; very soon after that of Puritans came into use as the general appellation of the dissenters, and it continued to be that by which they were commonly distinguished down to the close of the civil wars in the next century. The toleration of the dissenters, even in the most limited extent, dates only from the Revolution. During the century and a half that elapsed between the Reformation and that event, with the exception only of the short period of the Commonwealth, during which first the Presbyterians and afterwards the Independents had the ascendancy, they continued to be persecuted by a succession of restrictive and penal laws of almost constantly increasing severity. It was not till 1828 that the dissenters were raised from being a merely tolerated body to a free participation in the rights of their fellow-subjects, by the abolition of the Test and Corporation Acts. If the relaxation of the marriage law, that has since taken place, shall be followed by the abolition of Church rates, the dissenters will be placed as nearly on an equality in all respects with the adherents of the Established Church as it is possible that they should be, without the Established Church itself being abolished. In the early times of dissent the great classes of dissenters were the Presbyterians, the Independents, the Baptists, and the Quakers. The most numerous now are the Methodists, or followers of Wesley and Whitfield, some only of whom are avowedly dissenters. The Methodists are subdivided into Wesleyan Methodists, Primitive Methodists, United Free Church, &c. The minor sects of dissenters now make a long list; but many of them may be considered as only subdivisions of or included in the four leading denominations. Until the formation of the Free Church, the most numerous classes of dissenters in Scotland were those which originated in a separation from the Established Church in 1736. [Erskine, Ebenezer, in Biog. Div.] They were called generally Seceders, and were divided into Burghers, Anti-Burghers, Original Burghers, and Original Seceders. The greater number of the Burghers and Anti-Burghers united in 1820, under the designation of the United Associate Synod of the Secession Church; in 1847 this body united with the Relief Church (which originated in a separation from the Establishment in 1752), the aggregate body taking the name of the United Presbyterian Church. The Free Church of Scotland, which separated from the Establishment in 1843, forms now the most numerous body of dissenters in Scotland, although in some respects the members of the Free Church disclaim the designation of dissenters. These bodies are all Presbyterians, and differ chiefly on the theory of the relations of the Church to the State. The only considerable body of Scottish dissenters of older standing, with the exception of the Episcopalians, is that of the Cameronians, or Reformed Presbyterian Synod, who are the representatives of the Covenanters of the 17th century. The Congregationalists, or Independents, form a considerable body in Scotland; the Baptists, of whom there are several sections, are fewer in number. In Ireland, exclusive of the Roman Catholics, the principal dissenters are the Presbyterians, who are mostly confined to the province of Ulster. In the Census of 1851 an attempt was made to ascertain the number of each sect, by taking the number who attended divine service on a certain Sunday, but the result was confessedly imperfect, though it may afford a rough approximation. [Census of the United Kingdom, vol. ii., col. 723.]

DISSONANCE, in music, a term synonymous with discord. [Discord.]

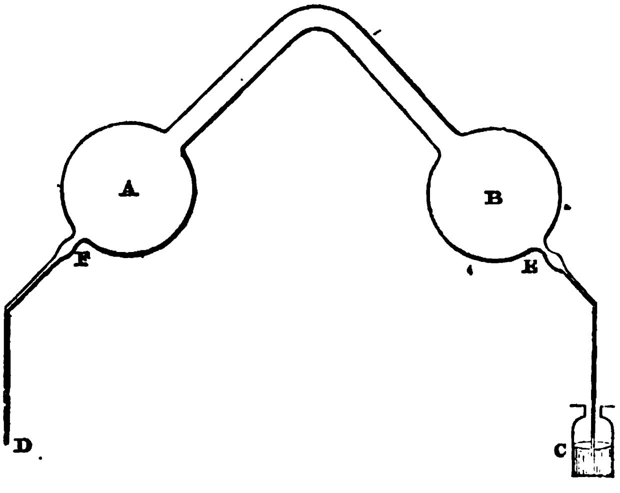
DISTANCE. The only remark which we need make upon this common word is that it is very frequently applied to *angular* distance, meaning the angle of separation which the directions of two bodies include. In the apparent sphere of the heavens, distance always means angular distance. The term *apparent* distance is frequently applied in the same case.

DISTEMPER, an inferior kind of colouring, in which size is the principal vehicle employed for mixing with the colour. It is used for both internal and external walls, but principally for the former, instead of oil colour, being a cheap substitute.

It is composed of whitening mixed with size of a coarse quality, in the proportions of twelve pounds of whitening to one of size. The size is boiled and reduced to a proper working consistency by the addition of water, after which the colour is added to form the necessary tint. Coarser colours are used for distemper than are employed in oil-painting and colouring. Scene-painting is executed in distemper, and paper-stainers employ distemper colour in printing and staining papers for walls. The colours used in these cases are, however, of a better quality, and the size employed is made from the hide of the buffalo, or parchment cuttings. The proportions of size and whitening in paper-staining depend on the strength of the size. In five quarts of distemper, if the size be strong, one-fourth part will be sufficient; if weak, about one-half. In mixing the size and whitening much depends on the judgment of the workman. The distemper is used in a chilled state. Five quarts will stain about eighty-four yards of paper.

The method of painting of the early Italian painters before the employment of oil as a vehicle, is known as *tempera*, from which term our word distemper as applied to painting is no doubt derived.

DISTILLATION. The process of separating, by the aid of heat, a volatile from a fixed or less volatile constituent. Sometimes the volatile matter so separated condenses as a solid, and then the process is termed *sublimation*. [Sublimation.] When the product obtained is the result of a change induced by heat upon the original substance, the operation is named *destructive* or *dry distillation*. The ordinary process of gas-manufacture, wherein certain liquid products are condensed, is a process of dry distillation. Distillation in the unqualified sense, however, signifies the volatilisation of a liquid by heat and its subsequent condensation in a separate vessel by cold. It is employed to separate a volatile liquid from less volatile solid or liquid matters. It is thus largely employed in the arts (see following article). In chemistry the operation is generally performed in an apparatus figured under Condenser. The material to be operated upon is placed in a *flask* or *retort* connected with the higher extremity of a condenser, which conducts the liquified product to a vessel called the *receiver*. In order to attain perfect purity from the less volatile matter, the process of distillation must in many cases be repeated, and it is then termed *rectification*. Some liquids, on being boiled in glass vessels, produce sudden bursts of vapour often causing the fracture of the vessel; this inconvenience may generally be remedied by placing platinum wire, or angular particles like quartz-sand, at the bottom of the vessel. Thus concentrated sulphuric acid can only be safely distilled in glass vessels, by first converting it into a magma with quartz sand. It is sometimes desirable to protect liquids from the air, or to lower their boiling points [Boiling of Liquids]; in either case distillation in vacuo is resorted to. When small quantities only of liquid are thus to be operated upon, the following is a very convenient form of apparatus :—



A B are two glass bulbs blown near the ends of a tube about one foot long, the extremities of the tube beyond the bulbs being drawn out as shown in the figure. The capillary tube attached to B is now immersed in the liquid to be distilled contained in the bottle C, and suction being applied to D, the necessary amount of fluid is raised into B, which is then so inclined as to prevent its return. The neck E of the capillary tube is now to be sealed off by the mouth-blowpipe, and the extremity D connected with an air-pump, by means of a caoutchouc joint. A vacuum being thus made in the bulbs, the tube D is fused off at F, and the distillation may now be commenced. The empty bulb A being immersed in cold water, the necessary heat is applied to B until a sufficient amount of the liquid has distilled over. The tube connecting the two bulbs must now be cut across with a triangular file, and the products removed from the bulbs.

DISTILLERY. Having, in the article DISTILLATION, explained the chemical principles on which all distilling processes necessarily rest, we shall now treat of these processes in their practical connection with manufactures, especially the distilling of ardent spirits in those great establishments known as distilleries.

The Arabians seem to have practised, in the remotest ages, the art of extracting the aromatic essences of plants and their flowers, in the form of distilled waters, to supply the luxuries of oriental baths. They are also supposed to have been the first to extract from wine a colourless intoxicating liquor by distillation. From certain passages in Pliny and Galen there can be no doubt that the Greeks and Romans were well acquainted with the distillation of aromatic waters. Indeed Nicander, a Greek poet and physician who lived 140 years before the Christian era, employs the terms ἄμβιξ *ambix* and distillation in describing the preparation of rose-water. From ambix, which signifies a pot, the Arabic name alambic or alembic is derived. The words *pot* and *poteen* are used in the same way by the modern Irish to designate a still and its spirituous product. It is obvious that distillation must have been a familiar process to the countrymen of Avicenna, since, in his treatise of catarrh, he compares the human body to an alembic; he regards the belly as the cucurbit or body, and the head as its capital, through which the humours distil, passing off by the nostrils as its beak.

Arnoldus de Villa Nova, a chemical physician of the 13th century, is the first author who speaks explicitly of an intoxicating spirit obtained by the distillation of wine; and he describes it as a recent discovery. He considers it to be the universal *panacea* so long sought after in vain. His disciple Raymond Lully, of Majorca, declares this admirable essence of wine to be an emanation of the Divinity, an element newly revealed to man, but hidden from antiquity because the human race were then too young to need this beverage, destined to revive the energies of modern decrepitude. He further imagined that the discovery of this *aqua vitæ*, as it was called, indicated the approaching consummation of all things—the end of the world. In his 'Chemical Theatre,' written towards the close of the 13th century, Lully describes the distillation of ardent spirits thus: "Limpid and well-flavoured red or white wine is to be digested during twenty days in a close vessel by the heat of fermenting horse-dung, and to be then distilled in a sand-bath with a very gentle fire. The true water of life will come over in precious drops, which being rectified by three or four successive distillations, will afford the wonderful *quintessence* of wine. . . . . To prove its purity," adds he, "if a rag be dipped in it, and kindled, it will not become moist, but consume away."

The only substances employed in this country in the manufacture of ardent spirits upon the great scale are different kinds of corn, such as barley, rye, wheat, oats, buckwheat, and maize. Peas and beans have been occasionally used in small quantity. The principles in these grains from which the spirits are indirectly produced are starch and a little sweet mucilage, which, by a peculiar process called *mashing*, are converted into a species of sugar. It is the sugar so formed which is the immediate generator of alcohol, by the process of fermentation. In mashing one or more kinds of corn, a greater or smaller proportion of malt is always mixed with the raw grain; and sometimes malt alone is used, as in the production of malt whiskey. The process of malting is that incipient growth called germination, in which, by the disengagement of a portion of the carbon of the starch, in the form of carbonic acid, the ultimate vegetable elements become combined in such a proportion as to constitute a species of sugar. Malting is the most effectual method of converting starch into sugar; although chemists are acquainted with other and very singular modes of effecting this transformation. By mashing, a larger or smaller proportion of the *fecula* of the corn is thereby converted into sugar, and thus brought into a state fit for producing alcohol by fermentation.

The manufacture of ardent spirit, whether known as whiskey or by any other name, consists in three distinct operations: first, mashing; second, fermentation; third, distillation.

1. *Mashing.*—Either malt alone, or malt mixed with other grain, and coarsely ground, is put into the mash-tun, along with a proper proportion of hot water; and the mixture is subjected to agitation by a mechanical revolving apparatus, similar to that employed in the breweries for the manufacture of beer. When malt alone is used, the water first run into the mash-tun among the meal has usually a temperature of 160° or 165° Fahrenheit; but when a considerable proportion of raw grain is mixed with the malt, the water is let on at a lower temperature, as from 145° to 155°. The following quantities have been found to afford a good product of whiskey in a well-conducted Scotch distillery:—

252	bushels of	malt,	at 40	pounds	per bushel.
948	„	barley,	53⅔	„	„
150	„	oats,	47¼	„	„
150	„	rye,	53⅔	„	„
1500					

From each bushel of the above mixed meal 2⅓ gallons of proof whiskey (specific gravity 0·921) may be obtained, or 18⅔ gallons per quarter. A few distillers are skilful enough to extract 20 gallons per quarter from such a mixture. Ten imperial gallons may be considered a fair proportion of water to be introduced into the mash-tun for every bushel of meal at the first infusion. After two or three hours' agitation, the whole is left to repose for an hour and a half, and then the worts are drawn off to about one-third the volume of water employed, the rest being entangled in a pasty state among the farina. About two-thirds of the first quantity of water is now let into the tun, but at a temperature somewhat higher; and the agitation is renewed for nearly half an hour. A second period of infusion or repose ensues, after which these second worts are drawn off. Both infusions must be cooled as quickly as possible down to the temperature of 80° or 70° Fahr., otherwise they are apt to run into the acetous fermentation by the rapid absorption of oxygen. This refrigeration is usually effected by exposing the wort for some time in large shallow coolers, placed near the top of the building, where it may be freely exposed to the aërial currents. But it is sometimes cooled by being passed through serpentine tubes surrounded with cold water, or by the agency of ventilators blowing over its surface in extensive cisterns only three or four inches deep.

After the second wort is drawn off, a third quantity of water, fully as great as the first, but nearly boiling hot, is run into the mash-tun, and well incorporated with the magma by agitation; after repose, this third wort is also drawn off, cooled, and either directly mixed with the preceding worts, or after it has been concentrated by boiling down; in most cases, however, it is reserved, and used instead of water for the first infusion of a fresh quantity of meal. The mashing and fermentation are jointly called *brewing*, and the period in which they are carried on is by law kept quite distinct from the *distilling* period, the one occupying usually one week, and the other the next in rotation. About 150 gallons of wort or wash are obtained from each quarter of corn employed.

The first of the above worts will have generally the density of 1·078 when the grain is good and the mashing is well managed, and the second a density of 1·054, so that the mixture will have a specific gravity somewhat above 1·060, and will contain about 60 pounds of extract per barrel. Now, by the excise rules, 100 gallons of such wort ought to yield one gallon of proof spirit for every five degrees of attenuation which its specific gravity undergoes in the fermenting tun, so that if it falls from 1·060 to 1·000, 12 gallons of proof spirit are supposed to be generated, and must be accounted for by the distiller. After an alteration in the excise laws some years ago, the distillers were allowed to ferment worts of less density than they previously could, and have been able to effect a more productive fermentation. They have been also enabled thereby to reduce the proportion of malt in the mixed meal. Formerly they were accustomed to use three parts of malt to four parts of barley, or two to three, but they soon diminished the malt to one-fifth, and latterly to one-eighth, or one-tenth, of the whole grain. One principal use of malt, besides its furnishing the saccharine ferment called diastase, is to keep the mash magma porous, and facilitate the drainage of the worts.

2. *Fermentation.*—This is undoubtedly the most intricate, as it is the most important process in distillation. Experiments have proved that the quantity of saccharine matter converted into alcohol is dependent upon the proportion of ferment or yeast introduced into the worts; if too little be used a portion of the sugar will remain undecomposed; and if too much, the spirits will contract a disagreeable taste. In general, the worts are let down at the specific gravity of 1·050 or 1·060, and at a temperature varying from 60° to 70° Fahr. For every 100 gallons one gallon of good porter yeast is immediately poured in and thoroughly incorporated by agitation with a stirrer. When by attenuation the density is diminished to 1·035, one half gallon more is added, and another half gallon at the density of 1·025, after which the worts usually receive no further addition of yeast. The temperature of the fermenting mass rises soon after the introduction of the yeast 8 or 10 degrees, and sometimes more; so that it reaches in some cases 85° or 90° Fahr. From the appearance of the froth or scum the experienced distiller can form a tolerably correct judgment as to the progress and quality of the fermentation. The greatest elevation usually takes place within thirty-six hours after the commencement of the process. The object of the manufacturer of spirits is to push the attenuation as far as possible; this so far differs from that of the beer-brewer, who wishes always to preserve a portion of the saccharine matter undecomposed to give flavour and body to his beverage. The first appearance of fermentation shows itself by a ring of froth round the edge of the vat usually within an hour after the addition of the yeast; and in the course of five hours the extrication of the carbonic acid from the particles throughout the whole body of the liquor causes frothy bubbles to cover its entire surface. The temperature meanwhile rises from 10 to 15 degrees, according to circumstances. The greater the mass of liquid, the lower the temperature at which it was let down into the tun, and the colder the surrounding atmosphere, the more slowly will the phenomena of fermentation be developed under a like proportion of yeast and density of the worts. In general large vats afford a better result than small ones, on account of the equality of the process. It is reckoned good work when the specific gravity comes down to 1·000, or that of water; and superior work when it falls 4 or 5 below it, or to 0·995.

After thirty-six hours upon the moderate scale the yeasty froth begins to subside; and when the attenuation gets more advanced, the greater part of it falls to the bottom on account of its density relatively to the subjacent fluid. In from forty-eight to sixty hours the liquor begins to grow clear, and becomes comparatively tranquil. It has been deemed advantageous towards the perfection of the fermentation to rouse up the wash occasionally with a proper stirrer, and in some cases to increase its temperature a few degrees by the transmission of steam through a serpentine pipe coiled round the sides of the vat. Some have imagined that a considerable portion of spirit is carried off by the great volume of carbonic acid evolved, and have proposed to save it by covering the vats air-tight, and conducting the gas through a pipe in the lids into a vessel containing water. The economy of this apparatus is not worth the expense and trouble which it occasions. The distillers content themselves with enclosing their vats after the first violence of the action under tolerably tight covers. It is found that the acetous fermentation is always proceeding simultaneously with the vinous fermentation: for judging by the usual tests there is always a slight degree of acidity in fermenting wash; that vinegar is in fact forming along with alcohol, or that while the attenuation is increasing, acetic acid is being formed. This important fact serves to show how very fallacious a test the attenuation or diminution of density is of the amount of alcohol generated and existing in a fermented wash. The acetic acid along with the undecomposed mucilaginous starch may, in fact, so far counteract the attenuating effect of the spirits as to produce a specific gravity which shall indicate 10 or 15 per cent. less spirit than is actually present in the wash.

It is computed that every 5 degrees of attenuation, as it is called, that is every diminution of the number 5 upon the specific gravity in the third place of decimals, ought to produce 1 per cent. of proof spirit, or 1 gallon out of 100; so that if the wort be set at 1·055, and come down to 1·000, 11 gallons of proof spirits are chargeable upon each 100 of such wash. In the fermentation of sugar worts, 1 gallon of proof spirits was calculated for every four degrees of attenuation; but distillation from sugar or molasses-wash is now illegal. With corn-wash there is never more than four-fifths of the saccharine matter decomposed into alcohol and carbonic acid, in the best-managed fermentation, and frequently indeed much less. In fact, each pound of real sugar may be resolved by a successful process into half a pound of alcohol, or into about one pound of proof spirit; and hence as a solution of sugar at the density of 1·060 contains 15 per cent. by weight, or 16 per cent. by measure, which is nearly 1·7 pounds per gallon, it should yield nearly 170 pounds from 100 gallons, or 180 pounds measure equal to 18 gallons of proof spirit; whereas 100 gallons of corn-wash, fermented at the above density, are computed by the excise law to yield only 12 gallons, and seldom produce more than 13 and a small fraction.

In the huge fermenting vats used by the corn distillers of this country, the fermentation goes on far more slowly than when conducted upon the moderate scale referred to in the account of this process given above. About 1 gallon of yeast is added at first for every 100 gallons of wort, and a half gallon additional upon each of the succeeding four days, making in the whole 3 per cent,; when less can be made to suffice, the spirits will be better flavoured. The fermentation goes on during from six to twelve days, according to the modifying influence of the circumstances above enumerated. After the fifth or sixth day, the tuns are covered in, so as to obstruct, in a certain degree, the discharge of the carbonic acid: since it is supposed that this gas in excess favours fermentation. The temperature is usually greatest on the fourth or fifth day, when it sometimes rises to 85° Fahr., from the starting pitch of 60° or 56°. Whenever the attenuation has reached the lowest point by the hydrometer, the wash ought to be distilled, since immediately afterwards the alcohol begins to be converted into acetic acid. This acidification may be partially repressed by the exclusion of atmospheric oxygen.

III. *Distillation.*—There are few kinds of chemical apparatus which have undergone so many metamorphoses as the still and condenser. In its simplest form it has been already represented and described. [ALEMBIC.] It may be considered to have reached its highest point of perfection, as to power and rapidity of work in Scotland, at the time when the distillers paid a stipulated sum per annum to the revenue for the privilege of using a still of a certain size, and when therefore they derived a profit proportionable to the quantity of spirits they could run off in a given time. Since the year 1815, the whiskey duties have been levied on the quantity distilled, independent of the capacity of the still. This change has introduced a modification in the distilling apparatus, with the view of combining purity of product with economy of time. The body of the still is still comparatively flat, so as to expose a large surface to the fire; but the tapering upper part, corresponding to the capital of an alembic, is made very long, rising sometimes 15 or 20 feet before it terminates in the worm pipe or refrigeratory for condensation.

Great distilleries are usually mounted with two stills, a larger and a smaller. The former is the *wash* still, and serves to distil from the fermented worts a weak crude spirit called *low wines;* the latter is the low-wine still, and rectifies by a second process the product of the first distillation. The annexed cut represents a copper wash-still, having a capacity of about 20,000 gallons. In these successive distillations a quantity of fetid oil, derived from the corn, comes over along with the first and last portions received, and constitutes by its combination what is styled, in the language of the distilleries, the strong and weak *faints.* These milky faints are carefully separated from the limpid spirit by turning them as they begin to flow from the worm-end into distinct channels, which lead to separate *receivers.* From these receivers the various qualities of spirit, low wines, and faints, are, for the purpose of redistillation, pumped up into charging backs, from which they are run in gauged quantities into the low-wine and spirit stills.

Wash Still.

One of the greatest improvements in modern distillation is the accomplishment of this essential analysis of the impure spirit at one operation. Chemistry had been long familiar with the pneumatic apparatus of Woulfe, without thinking of its adaptation to distillery apparatus; when Edouard Adam, an illiterate operative, after attending by accident a chemical lecture at Montpellier, where he saw that apparatus, immediately employed it for obtaining fine brandy, of any desired strength, at one and the same heat. He obtained a patent for this invention in July, 1801, and soon afterwards was enabled by his success to set up in that city a magnificent distillery, which attracted the admiration of all the practical chemists of the day. In November, 1805, he obtained a certificate of improvements whereby he could extract from wine at one process the whole of its alcohol. Adam was so overjoyed after making his first experiments, that, like another Archimedes, he ran about the streets telling everybody of the surprising results of his new invention. About the same time, Solimani, professor of chemistry at Montpellier, and Isaac Berard, distiller in the department of Gard, having contrived two distinct systems of apparatus, each most ingenious, and obtaining results little inferior to those of Adam, became in consequence formidable rivals of his fame and fortune.

The late Dr. Ure devised a form of distilling apparatus which to him appeared to combine the delicacy of the French with the solidity of the English forms. The lower the temperature of the spirituous vapour which enters into the refrigerator, the stronger and finer will the condensed spirit be; because the noxious oils are less volatile than alcohol, and come over chiefly with the aqueous vapour. A perfect still should therefore, he believed, consist of three parts: first, the cucurbit or boiler; second, the rectifier, for intercepting the greater part of the watery particles, and the whole of the corn oil; and third, the refrigerator. Three principal objects are obtained by this arrangement: first, the extraction from fermented wort or wine, at one operation, of a spirit of any desired cleanness and strength; second, a great economy of time, labour, and fuel; third, freedom from all danger of blowing up or boiling over by mismanaged firing. When a mixture of the alcohol, water, and essential oil, in the state of vapour, is passed upwards through a series of winding passages, maintained at a regulated degree of heat, from 170° to 180°, the alcohol alone, in notable proportion, retains the elastic form, and proceeds onward into the refrigeratory tube, in which these passages terminate; while the water and the oil are, in a great measure, condensed and retained in the passages, so as to drop back into the body of the still, and be discharged with the effete residuum.

The system of channels shown in *fig.* 2 is so contrived as to bring the compound vapours which rise from the alembic A into intimate and extensive contact with metallic surfaces, immersed in a water-bath, and maintained at any desired temperature by a self-regulating *thermostat* or heat-governor. The neck of the alembic tapers upwards as shown at B, *fig.* 1; and at C, *fig.* 2, it enters the bottom or ingress vestibule of the rectifier O F. F is its top or egress vestibule, which communicates with the under one by parallel cases, or rectangular channels, D, D, D, whose width is small compared with their length and height. These cases are open at top and bottom, where they are soldered or riveted into a general frame within the cavity, inclosed by the two covers F, C, which are secured round their edges E, E, E, with bolts and packing. Each case is occupied with a numerous series of shelves or trays, placed at small distances over each other, in a horizontal or slightly inclined position: of which a side view is given in *fig.* 3, and cross sections at D, D, D, *fig.* 2. Each shelf is turned up a little at the two edges and the one end, but sloped down at the other end; so that the liquor admitted at the top may be made to flow backwards and forwards in its descent through the system of shelves, as indicated by the spouts in *fig.* 3. The shelves of each case are framed together by two or more vertical metallic rods, which pass down through them, and are fixed to each shelf. On removing the cover, the sets of shelves may be readily lifted out of the cases to be cleaned; and are hence called *moveable*. The intervals I, I, I, *fig.* 2, between the two cases, are left free for the circulation of the water contained in the bath-vessel G, G; these intervals being considerably narrower than the cases. *Fig.* 4 represents in plan the surface of the rectifying cistern, shown by two different sections in *figs.* 2 and 3: H, K, *figs.* 2 and 4, is the thermostat or heat-governor, shaped somewhat like a pair of tongs. *Fig.* 5 is the refrigeratory, consisting of a double tube, placed in a zigzag direction, but in one plane, and supported by the two upright beams. The alcoholic vapour enters at the orifice K, and descends along the inner tube marked by dotted lines till it becomes condensed by the counter-current of water continually ascending in the annular space between that block-tin or copper tube, and the outer cast-iron pipe G. The water of condensation enters into that annular space at the point G, being supplied by the pipe D, and the nose of the stop-cock L. The funnel into which the cold water is poured must be somewhat higher than the point K, from which that water is discharged, after having been heated to the same temperature as that of the alcoholic vapour last exposed to its influence.

Fig. 3.

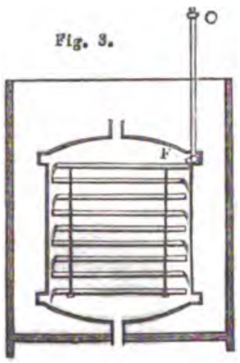


Fig. 2.

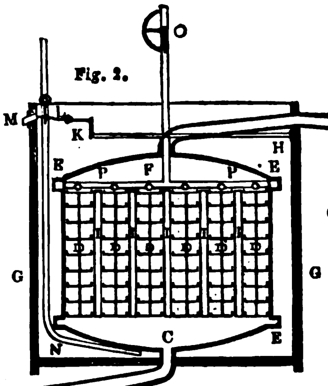


Fig. 5.

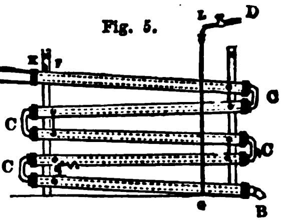


Fig. 1.

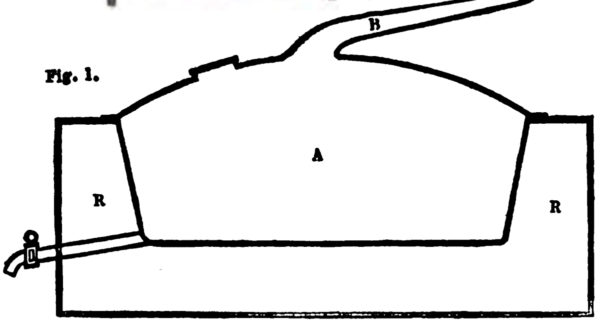
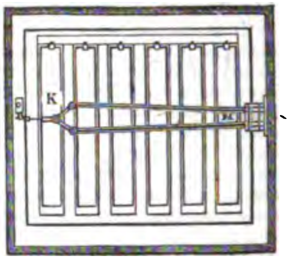


Fig. 4.



The still apparatus above described is worked as follows: Into the alembic put as much fermented liquor as will protect its bottom from being injured by the fire, when it is not plunged in a bath of muriate of lime, but exposed directly to the fuel. As soon as the ebullition in the alembic has raised the temperature of the water-bath G G to the desired rectifying pitch, whether 170° or 180°, the thermostatic instrument is to be adjusted by its screw-nut, and then the communication with the charging back or cistern is to be opened by moving the index of the stop-cock O over a proper portion of its quadrantal arch. The wash will now descend in a regulated stream through the pipe O F, thence spread into the horizontal tube P P, and issue from the orifices of distribution into the respective flat trays or spouts. The manner of its progress is shown for one set of trays in *fig.* 3. The direction of the stream on each shelf is evidently the reverse of that in the shelf above and below it; the turned-up end of one shelf corresponding with the discharge slope of its neighbour. By diffusing the cool wash or wine in a thin film over such an ample range of surfaces, the constant tendency of the bath to exceed the proper limit of temperature is counteracted to the utmost without waste of time or fuel; for the wash itself *in transitu* becomes boiling hot, and experiences a powerful steam distillation. Thus also a very moderate influx of water through the thermostat stop-cock suffices to temper the bath; such an extensive vaporisation of the wash producing a far more refrigerant influence than its simple heating to the boiling point. It deserves peculiar remark, that the greatest distillation with the least fuel is here effected without any pressure in the alembic; for the passages are all pervious to the vapour; whereas, in almost every wash-still heretofore contrived for similar purposes, the spirituous vapours must force their way through successive layers of liquid, the total pressure from which causes undue elevation of temperature, obstruction to the process, and forcing of the junctures. Whatever supplementary refrigeration of the vapours in their passage through the bath may be deemed proper will be administered by the heat-governor. The bath regulated by the thermostat may however be used for obtaining fine spirits at one operation, without transmitting the wash or low wines down through its interior passages; in which case it becomes a simple rectifier. The empyreumatic taint which spirits are apt to contract from the action of the naked fire on the vegetable gluten in contact with the bottom of the still, is somewhat counteracted by the rotation of chains in the large wash-stills; but it may be entirely prevented by placing the still in a bath of strong solution of muriate of lime R R, *fig.* 1, regulated by a thermometer or, still better, a thermostat. Thus a safe and effectual temperature of from 270° to 290° Fahr. may readily be obtained.

The principle of continuous distillation, just mentioned as having been adopted by Adam about sixty years ago, has been very extensively adopted by French distillers, in relation both to brandy from wine, and to liqueurs of various kinds. Bérard, Blumenthal, Derosne, Laugier, and others, have introduced successive improvements, which have rendered the French stills beautiful pieces of apparatus. In 1852, M. Boutigny, of Evreux, introduced a system of distilling in which two principles were especially held in view. The one was, so to condense the vapour almost at the instant of production, as to insure the conversion of all the alcohol into liquid; and the other was, so to manage the apparatus as to prevent anything from boiling up and over with the alcohol, which might contaminate it. A sheet of wire-gauze, in one or more layers, is placed so as to intercept all substances; while alcoholic vapour is allowed to pass. The vessels are so arranged, that the product distilled from the first apparatus shall serve to feed the second; the second a third; and so on: the last leading into a refrigerator. The boiling arrangements provide for a large heating surface, and a rapid evaporation.

Efficient as may be the French system, it has been found, however, that the small pipes and channels, which are suitable for the distillation from wine, would become clogged by the glutinous wash of malt or grain distillation. Mr. Eneas Coffey, of Dublin, patented a new apparatus in 1832, on the continuous system, which effected a very large saving of fuel; by causing the condensation of the spirit vapour through the agency of a portion of the cool wash, which thus became partially warmed, and to that extent forwarded in its progress. Coffey's still is now largely used in Scotland, in the distillation of grain whiskey; some of the stills are so large as to produce 3000 gallons per hour. Another kind of still, invented by Stein, is much used in Scotland for malt-whiskey. Most of the Scotch whiskey now sold in England is made from grain by Coffey's apparatus, and becomes marketable by mere dilution; but the malt-whiskey, mostly distilled in small establishments by the old apparatus, contains flavouring ingredients of various kinds. The peat-reek or turf-smoke flavour of some of the whiskey, made illicitly in out-of-the-way places, is, there is reason to believe, more or less imitated in whiskey distilled where no peat is employed—principally because English purchasers like that flavour, as an evidence of genuineness.

The great spirit-distilleries of England, if few in number, and not among the largest of our immense factory establishments, are certainly among those which contribute most amply to the revenue; indeed it may be doubted whether they have any parallel in this particular. In order that every gallon distilled may pay its share of duty, excise officers watch the operations with a closeness unequalled in any other department of British industry. It is difficult to say whether the distiller or the exciseman is more completely the master. Some of the London firms pay more than 300,000*l.* annually each to the revenue; and the Excise insists, not only that all the spirit made shall pay duty, but that the distillery shall be so conducted as to obtain the greatest quantity of spirit from a given quantity of malt or grain; thus the exciseman becomes virtually a chemist as well as a tax-collector. Moreover, the duty is paid per gallon of spirit of a certain defined strength; and the exciseman must be learned on the subject of specific gravity, to see that various degrees of dilution are not produced in such a way as to defraud the revenue. Excisemen, one or more, are never absent from the distillery, day or night, Sunday or week-day; they relieve guard, and one does not depart until his successor arrives. Each exciseman employed knows every vessel on the premises; he has a voice in the number, size, and shape of them; he is empowered to limit the number of openings in the more important vessels, and to trace the course and action of every pipe, valve, cock, and tap connected with each; he has duplicate keys to some vessels, and the *only* key to certain others; he can lock up the furnace doors, and lock up the stills, whenever he deems it his duty so to do; he can require, and does require, that the distilling of the wash into spirit shall not take place in the same week as the brewing of wort into wash; in order that he may know exactly how much wort and wash, as well as spirit, is in the several vessels at one time. He tests the specific gravity of all the liquids as often as he pleases; he requires that the numerous pipes shall be painted, some black, some red, some blue, and some white, in order that he may know which is for the conveyance of wort, which for wash, which for the first spirit, and which for the finished spirit; he demands the aid of ladders and passages to give him access to every part of every piece of apparatus: in short, the master distiller is so thoroughly controlled in all the operations, that nothing but the prospect of large profits, arising out of a large business, would induce a manufacturer to wear such shackles.

It is partly owing to this excise supervision, and partly to the enormous capital necessary, that the number of great distilleries remains pretty equal year after year. The following figures are interesting, showing the influence of different causes on the number of distilleries in different parts of the United Kingdom:—

		1834.	1844.	1854.
England:	Malt distilleries	0	0	0
"	Grain, or mixed distilleries . .	12	10	12
Scotland:	Malt distilleries	216	164	140
"	Grain, or mixed distilleries . .	23	11	15
Ireland:	Malt distilleries	1	2	0
"	Grain, or mixed distilleries .	80	59	43
		332	246	210

We thus see that, in 1854, there was not one *malt* distillery in England or Ireland; whereas, in Scotland, malt distilleries were nearly tenfold as numerous as those in which grain was employed, or grain mixed with malt. It will fall to be considered under the article SPIRITS, how much is produced yearly down to a much later date than 1854; but it will be useful to show here what was the ratio of production in the three kingdoms in the three years above named:—

	1834.	1844.	1854.
	Gallons.	Gallons.	Gallons.
England . . .	4,600,000	5,800,000	7,300,000
Scotland . . .	9,200,000	7,600,000	10,400,000
Ireland . . .	9,500,000	5,600,000	8,800,000
	23,300,000	19,000,000	26,500,000

England began to increase its relative ratio about the year 1851. To what extent poverty, to what extent temperance advocacy, caused the fluctuations in the Scotch and Irish ratios, this is not the place to discuss. Dividing the quantity of spirits which paid duty, by the number of distilleries known to the excise, it appears that, in 1854, the English distilleries produced 600,000 gallons on an average each, the Irish 200,000, and the Scotch 70,000; showing that the Irish distilleries were, on an average, only about one-third the size of the English, and the Scotch one-third that of the Irish. These ratios, however, may have undergone some modification by 1859; for it is known that there is a tendency to increase the size of the distillery establishments.

The process of distilling, hitherto described, has been that in which grain, either raw or malted, has yielded the saccharine element; but we have now to notice certain recent attempts to produce ardent spirits from *beet-root.*

That this can be done has long been known to chemists, practically in France, theoretically in England. The only question has been, whether beet-root distilling can be profitably conducted. One among many systems of operation patented is that of M. Le Play, depending on the fact that the refuse of the distillery can be profitably applied in the immediate neighbourhood of the distillery itself. In 1857 Mr. Dray, the agricultural implement maker, obtained permission from the Excise to make trial of Le Play's plan in a farm homestead owned by him at Farningham, in Kent. This consent was necessary, owing to the rigorous control exercised by the Excise over all spirit distilleries in this country. At Mr. Dray's homestead, spirit was distilled from the beet-root, and live stock were fed from the refuse. The roots, having been gathered from the fields, were washed, cut into slices, placed in vats, and allowed to ferment for twenty-four hours, the fermentation being aided by a little sulphuric acid. The same liquor was available many times over. The pulp, when removed from the vats, was placed in layers in cylinders, the layers being separated by perforated metal plates. The cylinders were then closed air-tight, and steam was admitted to the bottom of one of them. The steam extracted a juice or watery spirit from the pulp in the first cylinder, and passed thence into a second. The vapour was then condensed by passing through a worm in cold water, and, as a liquid, was received in a vat. While the first cylinder was being emptied and re-filled, steam was admitted to the second and third. The object of this three-fold process was, to make the operation a continuous one, and cause each portion of pulp to be acted on twice over, so as to render the extraction thoroughly complete.

The hopes and expectations relating to this system were thus set forth in a letter to the 'Times,' written by Messrs. Ridley: "It is much to be regretted that misconception prevails respecting the properties of beet-root to yield a fine consumable spirit. In France, during the last three years, millions of gallons have been distilled from this cereal, converted into and freely consumed as cognac brandy. So far this tends to demonstrate its superiority over grain for spirit-making purposes. Beet-root contains from 10 to 12 per cent. of solid saccharine matter, which, when disengaged by maceration and distilled in the ordinary manner, will yield, in good seasons, 25 gallons of proof spirit from one ton of root. The root can be cultivated at a cost of 10*s.* per ton; and allowing its value to be augmented to 20*s.*, or even 30*s.*, when used for distilling purposes, a very handsome profit might be obtained by selling its spirit at 2*s.* per gallon. Besides which, the pulp of the root, after being denuded of its saccharum, is in no way deteriorated as cattle food; on the contrary, some authorities assert that, being partially cooked, it is then more nutritious. Our Inland Revenue laws in many instances are found to operate obnoxiously against native enterprise. Why not allow our farmers freely to distil their produce and apply the refuse to fatten cattle, as is the common order of things on the continent, particularly in Germany. A new field might easily be opened for the cultivation of beet-root, on lands now lying waste, which could be profitably turned to account, to provide spirit for man and food for beast; while the highly-cultivated grain lands could be more exclusively devoted to their legitimate purpose of raising breadstuffs for the actual wants of the community."

This bright picture has hitherto been only a picture: either because the estimates were far beyond the average truth, or because the heavy spirit-duty operates as a bar to improvement in England. The Excise authorities have certainly not been obdurate in the matter. At Farningham, the spirit produced was found to be very raw, but was improved by rectifying; and it was proposed to fix a rectifying apparatus to the stills themselves, so as to complete all the operations on the spot. The spent pulp was said to be worth 15*s.* per ton, to be mixed with cut hay as a food for horses, cattle, and sheep. Listening to the representations made, the Excise, on the authority of the Treasury, permitted eleven more beet-root distilleries to be established in various parts of England. The result, after a year or so, came out as follows:—

	Root distilled.	Spirit obtained.	Produce per ton of root.
	Tons.	Gallons.	Gallons.
Ruddington . . .	517	4631	8·9
Lincoln	600	5710	9·5
Louth	834	4602	5·5
Laxton	397	3435	8·9
Fineshade	515	4201	8·1
Bolney	313	2074	6·6
Minety	759	7003	9·2
Crowmarsh	207	1260	6·0
Reading	460	4395	9·5
Otford	224	1782	7·9
Fulham	70	487	6·9

The produce thus varied from 5½ to 9½ gallons per ton, instead of 25 gallons according to the estimate. The Board of Inland Revenue thus reported on the whole subject in 1858 to the Treasury: "Messrs. Dray, who made the apparatus, and are licensed by the patentee of the process, represented to us so strongly the necessity of giving a fair scope to their experiment, by trying it on a large scale, and with the produce of various qualities of soil, that we obtained your lordships' leave (not without first ascertaining that the licensed distillers would have no objection) to permit the erection of twelve beet-root spirit distilleries in different parts of the United Kingdom, the selection of persons and of places being left to Messrs. Dray. Only ten (?) of these distilleries have been in operation; but as none of them have succeeded in producing a saleable spirit, or spirit of any kind in sufficient quantity per ton of root to pay their working expenses according to the calculations of the projectors, it may fairly be assumed that the process can never be successfully adopted in this country. The observations of our officers on the results obtained at each place will be found in the appendix; and it may therefore be sufficient to state here, that one of the most enterprising of these experimentalists has recently applied to the chairman of the Excise for protection against the grain distillers, in the shape of a differential duty of 2*s.* 6*d.* in his favour; and has acknowledged that, without some such advantage, it would be impossible for him to make a profit, or even to pay the working expenses of the distillery."

Whether the spirit be obtained from grain, malt, or beet-root, it is generally in too crude and distasteful a state to be used as beverage without further preparation. Whatever may be the case in Ireland or Scotland, the English spirit is always *rectified* before it passes into the hands of the retailer. The great distillers may not rectify their spirit; they must sell it in a crude state—this is a precautionary measure on the part of the Excise. The rectifiers buy the spirit, and convert it into gin, hollands, whiskey, British brandy, British rum, spirits of wine, and such cordials as aniseed, cloves, peppermint, &c. This is done by re-distilling, with water as a diluent; and by further distillation in company with such herbs, spices, seeds, berries, fruits, leaves, perfumes, or sweetening ingredients, as may be necessary to impart flavour. One of these distillations is called *rectifying*, and the other *compounding*. There is no limit to the varieties of flavour that may thus be produced. Spirits of wine contains none of these subsidiary ingredients; it contains only spirit and water, the spirit being strengthened to a great degree of intensity.

A very interesting kind of distilling, whereby sea water is converted into fresh, will be more conveniently treated under FILTER, in connection with other modes of purifying water.

DISTORTION. Deformity of the person may be advantageously classed for the purpose of discussion under two principal heads: *malformation* and *distortion*. The former is, for the most part, congenital, and is usually characterised by the deficiency or redundancy of parts, or by imperfections and irregularities of structure. The latter, arising generally after birth, comprises all permanent deviations from the natural shape or position which are effected by the influence of external or internal force in parts originally soft and flexible, or such as have acquired unnatural pliancy by accident or disease.

It is to the latter class of deformities only that our attention is for the present directed. But even thus limited, the subject is so extensive that we must once for all refer the reader for more precise information on several of its most interesting subdivisions to professional works. [CONTRACTION.]

I. Every part of the body capable of independent motion is furnished with two sets of muscles, acting in contrary directions, the purpose of which is obviously to bring the part back to its place after movement in either direction. In the position of equilibrium these muscles are not in a state of absolute relaxation, even during sleep; on the contrary, they continue to act with considerable energy, each exactly counterbalancing the other. This is called their tone or tension, and it is calculated to give great steadiness to the part thus held at rest between opposite forces. But if one set of the muscles should be suddenly cut across, the tension of their antagonists still remaining in action, the consequence would be a movement in obedience to the latter till the contraction had reached its limit; and the part in question would permanently retain the position into which it had thus been moved. The same effect would result if the muscle, instead of being divided, were paralysed by the interruption of its nervous communication with the brain. Again, if the tone of one muscle were increased by spasm or otherwise, so as to give it a decided preponderance over its antagonist, the result would be similar. These considerations will sufficiently explain the nature of one large class of distortions, namely, those which result from affections of the *brain, muscles*, and *nerves*.

1. The simplest of these is the *drawn mouth*, or *hemiplegia*. It arises in this way: in consequence of an extravasation of blood or some other cause, the functions of one side of the brain are interrupted; the muscles of the cheek on the same side, deriving their nerves from that part of the brain, are paralysed, and the retractors on the opposite angle of the mouth being no longer balanced by an equal force, draw it up towards their origin, and retain it in that position.

2. *Strabismus*, or squinting, is frequently produced in the same way by a partial paralysis of that muscle the office of which is to turn the globe of the eye in the opposite direction, or it may arise from undue contraction of the muscle on the same side.

3. It is remarkable that *hysteria* is sometimes accompanied by a distortion of the last-mentioned kind, produced by a spasmodic contraction of the flexor muscles of one of the joints, commonly the knee or hip. For months or years this painful condition may last without mitigation: yet it may vanish all at once under the influence of some powerful impression of the body or mind. The entire loss of the voice, which sometimes comes on suddenly in similar constitutions, and after long resisting every remedy, as suddenly departs, is probably an analogous affection of the muscles of the larynx.

4. *Wry-neck* is a distortion also due to irregular muscular action. It generally comes on gradually in infancy, and consists in a shortened and contracted state of the *sterno-mastoid* muscle, of that side to which the head is inclined and *from* which the face is turned. *Club-foot* is often nothing more than a similar contraction of the muscles of the calf, which draw up the heel and eventually disturb the integrity of the ankle joint. This complaint also comes on at an early age, and is sometimes congenital. By proper means they both admit of relief, and often of a cure. [CONTRACTION.]

The list of distortions depending on a morbid condition of the muscular or nervous functions might easily be extended.

II. But by far the most common and important class of these affections is that which originates in disease of the bones.

1. The firmness and rigidity of the bones depends upon the due proportion of the earthy matter, phosphate of lime, that enters into their composition. If the proportion of this ingredient be too great, as in old age, and in the disease called *fragilitas ossium*, they become brittle, and are broken by the slightest causes; if it be too small, they become unnaturally pliant, and are distorted by the pressure of the superincumbent weight, or the contraction of the muscles.

The latter condition is prevalent with other structural changes in the disorder called *rickets*. The medical name of this complaint is *rachitis* (from ῥάχις, the spine), and was given to it by Glisson, who first described it, partly because he conceived the vertebræ to be the bones most commonly implicated; but chiefly, it would appear, from the resemblance to the English name. His doctrine was erroneous; and the error perpetuated by the misnomer has led to serious mistakes in practice as well as theory. The spine is undoubtedly liable to partake with the rest of the skeleton in the morbid condition of rickets, but certainly not in a greater degree than the other bones.

This malady seldom appears within the ordinary period of lactation, or after puberty. It is ushered in and attended throughout by general febrile disturbance, and is closely connected with a peculiar morbid condition of the nutritive functions. The opinion that it is of scrofulous origin has lately been strongly controverted, and does not in reality appear to be well supported by facts. It is most common among the poor, and in closely-peopled districts, as all the diseases of children are; but it is by no means confined to either, or to children whose constitutions are apparently the most feeble in other respects. Indeed it is a frequent remark, that the most robust and powerful men exhibit tokens of having been rickety in their childhood. Among such indications are smallness of the pelvis, with inward or outward curvature and disproportionate shortness of the lower limbs. This sudden check to the development of the skeleton, constantly observed in rickety children, with the distortion arising from the unnatural softness of the bones, is the most usual cause of the short stature, as well as the proverbial ugliness, of dwarfs.

In extreme cases of this complaint the head is generally small and pointed: no longer supported by the yielding and shortened neck, it sinks down between the shoulders; the occiput is thrown back and almost touches the hump formed by the incurvated spine behind the chest: the chin is thrust forward, giving an expression to the features very characteristic of the dwarf, and rests upon the breast bone, which is very prominent: on each side the ribs are flattened, and bulge in upon the lungs. The shoulders, losing the support of the wreathed and twisted clavicles, approach towards each other in front, drawing with them the scapulæ, which stick out laterally, and add considerably to the deformity as seen from behind; the arms, though bent and in reality shortened, seem of disproportionate length; the lumbar spine is thrust inwards; the pelvis is small and flattened; the thighs are bowed forward; the knees with their patellæ at the side instead of in front of the joint, touch or overlap each other; while the feet are set wide apart, a sudden twist above the ankle still permitting the soles to be set to the ground. Such are some of the varied changes which exhibit a melancholy proof of the prevalence of the disease in every part of the bony frame, and almost defy description. Of course such extreme cases of rickety distortion are comparatively rare; yet almost daily instances are seen by those whose duty calls them into the unwholesome courts and alleys of the metropolis, and slighter examples of the affection are extremely common.

Recovery, even from considerable degrees of this affection, is more frequent and rapid than might be imagined; but the pelvis and lower limbs, which as above-mentioned, are the most commonly and extensively implicated, seldom completely regain their natural proportions. This fact, as it regards the female pelvis, is worthy of notice, being the cause of by far the most dangerous kind of difficult parturition. It is in extreme cases of this sort that the Cæsarean section has been practised.

Independently of rickety distortion, there are two other kinds of curvature of the spinal column which demand a brief notice.

The first, which has frequently been mistaken for rachitis, is usually called *lateral* curvature, to distinguish it from the more serious kind of distortion next to be considered, which is called *angular* curvature.

2. Unlike rickets, which almost always commence in infancy or early childhood, lateral curvature of the spine seldom appears before the tenth year. The external deformity consists in the prominence of one hip (generally the right), and elevation of the corresponding shoulder, the blade of which sticks out in unsightly protuberance behind. The opposite hip and shoulder are respectively flattened and depressed; and the symmetry of the chest is destroyed, one side being larger than the other, and both twisted and misshapen. On examination the spine is found to have a double curvature sideways, so as to resemble the letter S, but generally turned the other way, the concavity of the lower curve being on the right, and the upper on the left side. It arises from weakness in the spinal muscles and local elongations of the ligaments of the vertebræ, from the habit of resting the weight in sitting or standing more on one side than the other; and that side is usually the right. The position is more easy than the upright one, and when not corrected by fitting exercise and change in the nature of the employment, it becomes habitual, and the twist of the person permanent and increasing. The subjects of this kind of distortion are chiefly slender and delicate girls in the middle and upper classes, the poor being comparatively exempt. It comes on insidiously, the attention not being awakened by any particular derangement of the health beyond a certain degree of languor and susceptibility of fatigue, and perhaps a sluggish state of the digestion. The first symptom that betrays its presence is usually a tendency of the dress to slip off the left shoulder. It is much promoted by means often used to prevent it, such as confinement and restraint of the person and posture by stays, backboards, high-backed chairs, reclining on a board, and other contrivances to improve the figure, and restrain the development of the natural form; as well as by the sedentary habits and inappropriate exercises of the academy or school-room. Nature is not to be coerced with impunity by fantastic caprices and contrivances: a good figure as well as good health must be found, if anywhere, in the open air of the fields, in loose and easy clothing, and in unrestrained exercise of the limbs, such as children will always adopt, if left to choose for themselves, in ways much better suited to their age and strength than any that can be invented for them.

3. Angular curvature of the spine is a deformity very different in its nature and appearance from the last described. It arises for the most part from ulceration of a scrofulous kind in the bodies of the vertebræ. The support in front being thus lost, the spine is sharply bent forwards so that one or more of the spinous processes project behind, indicating the position of the diseased vertebræ. This complaint is attended with incomplete paralysis of the lower extremities, and is not unfrequently fatal. In case of recovery the bodies of the contiguous vertebræ are approximated and consolidated with what remains of those which were diseased by the deposition of bony matter. It is in this species of spinal complaint only that rest and the recumbent posture are expedient. The observance of these essential precautions, concurrently with other means, frequently brings about a cure; the distortion however is permanent.

Diseases of a similar kind frequently occur in the bones and joints of other parts of the body; they require similar treatment, and are followed by analogous consolidations and distortions.

4. Rheumatism and other disorders, and even common inflammations, occurring in a high degree within the joints or in their neighbourhood, occasionally produce like effects.

III. Distortions are sometimes occasioned by the contraction of other parts than those which are concerned in motion.

1. Such are those of the fingers, which arise from chronic inflammation and permanent contraction of the palmar aponeurosis, or fascia, a strong inelastic and fibrous membrane attached to the projecting points of bone, and stretched beneath the skin of the palm for the protection of the nerves and other soft parts during the act of forcible grasping. There is a similar aponeurosis in the sole of the foot, which is subject, but not so frequently, to the same shortening. Under this division may be also classed those distortions which arise from burns and other extensive destructions and ulcerations of the skin, in consequence of the contraction of the scar in the process of healing. When these injuries take place in front of the neck and face, the resulting deformity is sometimes frightful. The space between the chin and the breast is filled up by a tense discoloured and corrugated cicatrix, which bows the head forward and draws down the features so as to expose the inner surface of the lower eyelid and keep the mouth constantly open. When they occur in the flexures of the joints, as in front of the elbow, the cicatrix extends in the form of a hard and rigid web between the humerus and fore-arm, the joint being permanently bent. Such deformities may sometimes be partly removed by an operation; but it is extremely painful, and often unsuccessful.

2. A slight injury of the face below the eye, or the simple contraction from some other cause of the skin of that part may produce the deformity called *ectropium*, or eversion of the lower lid; and the opposite state of inversion (*entropium* or *trichiasis*) may result from a similar contraction of the edge of the eyelid itself. Severe inflammation, and even blindness, may be the consequence of the latter affection from the friction of the lashes against the globe. Both of these deformities may be remedied by a slight operation.

IV. Another class of distortions may arise from external pressure; as of the bones and cartilages of the chest from tight stays; or of the phalanges of the toes from ill-made shoes. Instances of this kind of distortion must be familiar to all; and call for no particular explanation or remark.

DISTRESS, *districtio* in the jurisprudence of the middle ages, denotes legal compulsion generally, whether ecclesiastical or civil. One mode of compulsion extensively adopted among the nations of Teutonic origin was the taking possession of the whole or a part of the property of the offender or defaulter, and withholding it from him until the requirements of the law had been complied with. This species of distress was called "naam," from nyman, nehman, to take—a verb common to the Anglo-Saxon, German, and other cognate languages. The modern distress is the "naam," restricted to the taking of *personal* chattels; and in its most simple form it may be stated to be—the taking of personal chattels out of the possession of an alleged defaulter or wrong-doer, for the purpose of compelling him, through the inconvenience resulting from the withholding of such personal chattels, to perform the act in respect of which he is a defaulter, or to make compensation for the wrong which he has committed.

Some rights to which the law annexes the remedy by distress, have been considered as too important to be left to the protection afforded by the mere detention of the *distress* (by which term the thing taken is also designated), and more efficacious means of dealing with it have been introduced; and in certain cases a sale of the property taken by way of distress is allowed, if, after a certain interval, the party distrained upon continues to be unwilling or unable to do the act required.

Distresses are either for some duty omitted, some default or nonfeasance,—or they are in respect of some wrongful act done by the distrainee; that is, the person whose goods are distrained upon.

I. *As to distresses for omissions, defaults, or nonfeasance.*—These may be grounded upon non-compliance with some judicial requirements, or they may be made by private individuals in vindication of certain rights, for the withholding of which the law has entrusted them with this remedy.

The process out of courts of record ordering such distresses to be made, is called a writ of *distringas*, which, when legal proceedings were in Latin, was the word used to direct the sheriff or other officer to make the distress.

Another class of judicial distresses is where, upon refusal or omission to pay a sum in which a party is convicted upon a summary proceeding before justices of the peace, such justices are empowered to grant a warrant authorising and directing the levying of the amount by distress and sale of the goods of the offender.

Another species of judicial distress is that awarded and issued upon a judgment recovered in an inferior court, not of record. In these cases the execution or remedy for obtaining payment of the sum recovered is by distress. A precept issues to the officer of the court, commanding him to take the goods of the party, and to impound them until he satisfies the debt. Such process issues at the command of the sheriff, or of the lord of the manor, &c., in whose name and by whose authority the courts are holden.

So a distress lies, subject to certain restrictions, for fines and amercements imposed in the sheriff's tourn and in a court-leet. [LEET; TOURN.]

A penalty inflicted for the breach of a bye-law [BYE-LAW] may be levied by distress, in cases where that remedy is appointed at the time of the making of the particular bye-law. But a bye-law establishing a distress cannot authorise the sale of the distress.

Another species of judicial distress is a distress taken for various rates and legal assessments.

In the foregoing cases the right or duty withheld has been ascertained by some judicial determination before a distress can be resorted to. But many payments and duties having their origin in feudal rights may be enforced by distresses taken by the sole authority of the parties claiming such payments or duties. The rights, of which the vindication is thus in the first instance entrusted to the parties themselves, are connected immediately or mediately with feudal superiority; and it is observable, that to feudal superiority, jurisdiction and magisterial authority were always incident.

Among the feudal duties which may be enforced by distress, at the mere will of the party claiming to be entitled to such duties, one, which though seldom exacted, is still of the most extensive obligation, is fealty. Fealty is a promise, confirmed by an oath, to be faithful in the performance of those engagements into which the party doing the fealty (as the act of taking the oath is termed) has expressly or impliedly entered upon becoming tenant to the party receiving the fealty.

A distress also lies for suit of court, *secta ad curiam*, or the attendance which freehold tenants owe to their lord's court-baron, or freeholders'-court, and which tenants in villenage or copyholders owe to the lord's customary court; and it is not unusual for lessees for years to covenant to attend the lord's courts, though, unless they also fill the situation of freeholders of the manor, they are not qualified to sit as suitors and judges in the court-baron; and unless they are copyholders, they cannot be sworn upon the homage or jury in the customary court. This suit is sometimes called suit-service, to distinguish it from suit real, which is that suit of court which the resiants, or those who dwell within a hundred or a leet, owe to the sheriff's tourn or to the court-leet. [Leet; Suit.]

A distress lies for suit of mill (*secta ad molendinum*), an obligation, still existing in some manors, to grind at the lord's mill.

So for frankfoldage, or a right in the lord to require his tenants to fold their sheep upon his lands.

So, if land be holden by the tenure of repairing a bridge, or a highway, or of doing suit to a leet, or filling some office within the leet, a distress will be for non-performance of the service, although no fine or amercement may have been imposed in the court leet.

The most important feudal duty for which a distress may be taken is *rent*. Rent, in its original and still most usual form, is a payment rendered by the tenant to his landlord as an equivalent or a compensation for the occupation of land, &c. Such rent is denominated rent-service. It comes in lieu of, and represents the profits of the land granted or demised, and is therefore said to *issue* out of the land. To rent-service the law annexes the power of distress, although there be no agreement between the parties creating that remedy. But a rent reserved upon a grant or demise ceases to be a rent-service if it be disannexed from the ultimate property in the land, called in some cases the reversion, in others, the right of reverter. Thus, if the owner of land in fee demises it for a term of years, reserving rent, and afterwards assigns the rent to a stranger, retaining the reversion, or grants the reversion, retaining the rent, the rent being disconnected from the reversion is considered as a branch severed from the trunk, and is called a dry rent or rent-seck, to which the common law annexed no power of distress. So, if the owner of the land, without parting with the land, grants to another a rent out of the land, the grantee having no reversion had only a rent-seck, unless the grant expressly created a power of distress, in which case the rent would be a rent-charge. But now, by statute 4 George II. c. 28, s. 5, the like remedy by distress is given in cases of rent-seck, as in the case of rent reserved upon lease.

And as all rents, though distinguished by a variety of names derived from some particular circumstance attached to them, are resolvable into rent-service, rent-seck, or rent-charge, a distress lies at this day for every species of rent, though a practical difference still subsists as to the mode of dealing with distresses taken for the one or for the other. As to the several species of rent, and as to the creation, transfer, apportionment, suspension, and extinction of rents, and as to the estate or interest of the party necessary to support a distress for rent, and the cases in which this remedy may be exercised by the personal representatives of such parties, see Rent.

A *heriot* appears to have been originally a voluntary gift by the dying vassal to his chieftain or lord (*herr, herus*) of his best horse or armour. It has now become a legal liability to deliver the best animal of the deceased tenant to be selected by the lord, or sometimes a dead chattel or a commutation in money. Where heriot is due by usage within a particular district, in respect of all tenants dying within that district, without reference to the property held, it is heriot-custom; and as there is no particular land charged with the heriot, the lord cannot distrain, but may seize the heriot as his own *property*, his election being determined by the bare act of seisure. But heriot due in respect of the estate of the tenant in the land is heriot-service; and for this the lord may either distrain upon the land to compel the tenant to deliver or procure the delivery of the heriot due upon the death of his predecessor, or he may choose for himself, and seise the heriot as his own property (the right of property vesting here also upon the election exercised and signified by the seisure).

As heriot is something rendered upon the death of a tenant, so *relief* is a payment made by the heir upon the taking up (*relevatio*) by him of the inheritance. Strictly speaking, relief was payable in those cases only where the tenure was by knight's service. But the name was afterwards extended to a payment in the nature of a relief made by the heir in socage, by doubling the rent for the first year after the descent of the land,—in other words by paying one year's additional rent. For this latter payment a distress still lies.

Toll is a charge or impost upon goods in respect of some benefit conferred or right forborne with relation to those goods, by the party claiming such toll.

Tolls of fairs or *markets* are a duty payable to the owners of the fair or market as a compensation for the mischief done to the soil by the holding of such fair or market.

Toll-traverse is a compensation paid in some cases to the owner of the soil in respect of the transit or passage of goods.

Toll-thorough is a toll for the transit of goods along a street or highway repaired by the party claiming the toll.

Port-tolls, more commonly called *port-duties*, are tolls payable in respect of vessels coming to or sailing from a port or a wharf of which the parties claiming the tolls, or those from whom they derive their title to such tolls, are the owners.

In all these cases, if the toll be withheld, any part of the property chargeable therewith may be seized and detained as a pledge for the payment of such toll.

II. *Distress because damage-feasant.*—Besides distresses for omissions, defaults, or nonfeasance, this remedy is given in certain cases as a mode of obtaining reparation for some wrong done by the distrainee. Cattle or dead chattels may be taken and detained to compel the payment of a reasonable sum of money by way of satisfaction for the injury sustained from such cattle or dead chattels being wrongfully upon property in the occupation of the party taking them, and doing damage there, either by acts of spoliation or merely by incumbering such property. This is called a distress of things taken damage-feasant (doing damage).

The occupier of land, &c., is allowed not only to defend himself from injury by driving out or removing the cattle, &c., but also to detain the thing which did the injury till compensation be made for the trespass; for otherwise he might never find the person who had occasioned the trespass. Upon referring to Spelman and Ducange, it will be seen that a similar practice obtained on the continent amongst the Angli, Werini, Ripuarii, and Burgundians.

The right to distrain damage-feasant is given to all persons having an immediate possessory interest in the soil or in its produce, and whose rights are therefore invaded by such wrongful intrusion. Thus, not only the occupier of the land trespassed upon, but other persons entitled to share in the present use of the land or of the produce, as commoners, &c., may distrain. But though a commoner may always distrain the cattle, &c., of a stranger found upon the common, it would seem that he cannot, unless authorised by a special custom, distrain the cattle, &c., of the person having the actual possession of the soil. Nor can he distrain the cattle of another commoner who has stocked beyond his proportion, unless the common be stinted, that is, unless the proportion be limited to a certain number. In the more ordinary case of rights of common in respect of all the cattle which the commoner's enclosed land can support during the winter, cattle exceeding the proportion cannot be distrained.

Cattle found trespassing may be distrained damage-feasant, although they have come upon the land without the knowledge of their owner and even through the wrongful act of a stranger. But if they are there by the default of the occupier of the land, as by his neglecting to repair his fences, or to shut his gates against a road or a close in which the cattle lawfully were, such negligent occupier cannot distrain unless the owner of the cattle suffer them to remain on the land after notice and time given to him to remove them; and if cattle trespass on one day and go off before they are distrained, and are taken trespassing on the same land on another day, they can be detained only for the damage done upon the second day.

Cattle, if once off the land upon which they have trespassed, though driven off for the purpose of eluding a distress, cannot be taken even upon immediate pursuit. The occupier is left to his remedy by action.

III. *What may be distrained.*—In distresses for rent and other duties, that which is taken must be something in which a valuable property may exist. But animals of a wild nature, if reclaimed and become valuable (as deer kept in a private park), may be distrained.

Fixtures, not being personal chattels, are not subject to distress. Nor were growing crops subject to distress by the common law; but now, by 11 Geo. II. c. 19, s. 8, distress for rent-service may be made of all sorts of corn and grass, hops, roots, fruit, pulse, or other product whatsoever growing in any part of the land demised.

By the common law nothing could be distrained upon for rent or other duty that could not be restored in as good plight as at the time of the distress being taken; and therefore fruit, milk, and other matters of a perishable nature could not be distrained, nor money unless in a bag, because the identical pieces could not be known so as to be restored to the distrainee; nor could grain or flour be taken if out of the sack, or hay not being in a barn, or corn in the sheaf, because the quantity could not be easily ascertained, and they might be scattered or injured by the removal. None of these could be taken as a distress except for damage-feasant, though the same articles when contained in bags, boxes, carts, or buildings might be distrained upon for rent. But now by 2 Will. & Mary, sess. 1, c. 5, s. 3, distress may be made of sheaves or cocks of corn, or corn loose or in the straw, or hay lying or being in any barn or granary, or upon any hovel, stack, or rick, or otherwise, upon any part of the land.

Where a stranger's cattle are found upon the tenant's land they may be distrained upon for rent-service, provided they are there by the act or default of the owner of such cattle. If they come upon the land with the knowledge of their owner, or by breaking fences which are in repair, or which neither the landlord nor the tenant is bound to repair, they are immediately distrainable; but if they come in through defect of fences which the lord or tenant is bound to repair, the lord cannot take them for rent reserved upon a lease until they have lain for a night upon the land, nor until after notice given to the owner, if he can be discovered, to remove them. But in the case of a lord not bound to repair the fences distraining for an ancient rent or service, and also in the case of a rent-charge, the cattle may be taken, after they have lain a night upon the land, without notice to their owner.

Things necessary for the carrying on of trade, as tools and utensils,—

or for the maintenance of tillage, as implements of husbandry, beasts of the plough, and sheep as requisite to manure the land, are privileged from distress whilst other sufficient distress can be found. But this rule does not extend to a distress for a toll or duty arising in respect of the thing taken as a distress, or of things connected with it; as a distress of two sheep for market-toll claimed in respect of the whole flock, or of the anchor of a ship for port-duty due in respect of such ship.

For the protection of tradesmen and their employers in the necessary transactions of society, property of which the distrainee has obtained the possession with a view to some service to be performed upon it by him in the way of his trade, is absolutely privileged from distress; as a horse standing in a smith's shop to be shod, or put up at an inn, or cloth sent to a tailor's shop to be made into clothes, or corn sent to a mill or market to be ground or sold. The goods of a guest at an inn are privileged from distress; but this exemption does not extend to the case of a chariot standing in the coach-house of a livery-stable keeper; nor does it protect goods on other premises belonging to the inn but at a distance from it; and even within the inn itself the exemption does not extend to the goods of a person dwelling there as a tenant rather than a guest. Goods in the hands of a factor for sale are privileged from distress; so goods consigned for sale, landed at a wharf, and placed in the wharfinger's warehouse.

Beasts of the plough may be distrained where no other distress can be found. And it is sufficient if the distrainor use diligence to find some other distress. A distress is not said to be found unless it be accessible to the party entitled to distrain, the doors of the house being open, or the gates of the fields unlocked. Beasts of the plough may be distrained upon where the only other sufficient distress consists of growing crops, which though now subjected to distress, are not, as they cannot be sold until ripe, immediately available to the landlord.

A temporary privilege from distress arises when the chattel is in actual use, as an axe with which a man is cutting wood, or a horse on which a man is riding. Implements in trade, as frames for knitting, weaving, &c., are absolutely privileged from distress whilst they are in actual use, otherwise they may be distrained upon if no other sufficient distress can be found.

By 7 Ann. c. 12, s. 3, process whereby the goods of any ambassador or other public minister of any foreign prince or state, or of their domestic servants, may be distrained, seized, or attached, is declared to be null and void. But the privilege of a domestic servant of an ambassador does not invalidate a distress for the rent, rate, or taxes of a house occupied for purposes unconnected with the service.

By the Bankrupt Law Consolidation Act, 12 & 13 Vict. c. 106, s. 129, no distress for rent made and levied after an act of bankruptcy upon the goods of any bankrupt shall be available for more than one year's rent accrued prior to the date of the filing the petition; but the party to whom the rent is due shall be allowed to come in as a creditor for the overplus of the rent due, and for which the distress shall not be available.

Where a tenancy for life or at will is determined by death, or by the act of the landlord, the tenant, or his personal representatives, may reap the corn sown before such determination, and therefore such corn though sold to a third person, cannot be distrained upon for rent due from a subsequent tenant. [EMBLEMENTS.]

Neither the goods of the tenant nor those of a stranger can be distrained upon for rent if they are already in the custody of the law, as if they have been taken damage-feasant, or under process of execution. But although the landlord cannot distrain, yet by 8 Ann. c. 14, he has a lien or privilege upon the goods of his tenant taken in execution for one year's rent. [EXECUTION.]

IV. *Time of making a distress.*—Rent is not due until the last moment of the day on which it is made payable. No distress therefore can be taken for it until the following day. And as a continuing relation of landlord and tenant is necessary to support a distress for rent-service, there could at common law be no distress for rent becoming due on the last day of the term. But now, by 8 Ann. c. 14, ss. 6 and 7, any persons having rent in arrear upon leases for lives, for years, or at will, may, after the determination of such lease, distrain for the arrears, provided that such distress be made within six calendar months after the determination of the lease and during the continuance of the landlord's title or interest, and the possession of the tenant from whom such arrears are due. If the possession of the tenant continue in fact, it is immaterial whether that possession be wrongful and adverse, or whether it continues by the permission of the landlord; and if a part only of the land remain in the possession of the tenant, or of any person deriving his possession from the tenant, a distress for the whole of the arrears may be taken in such part during the six months. Where a tenant is entitled by the terms of his lease, or by the custom of the country, to hold over part of the land or buildings for a period extending beyond the nominal term, the original tenancy will be considered as continuing with reference to the land, &c., so retained, and the landlord may distrain at common law for the arrears during such extended period in the lands, &c., so held over, and he may distrain under the statute during six months after such partial right of possession has entirely ceased.

When different portions of rent are in arrear, the landlord may distrain for one or more of those portions, without losing his right to take a subsequent distress for the residue; so, although the first distress be for the rent last due. But if there be a sufficient distress to be found upon the premises, the landlord cannot divide a rent accruing at one time into parts, and distrain first for a part and afterwards for the residue. If, however, he distrain for the entire rent, but from mistaking the value of the goods takes an insufficient distress, it seems that a second distress for the deficiency will be lawful, although there were sufficient goods on the premises to have answered the whole demand at the time of the first taking; and it is clear that he may take such second distress upon goods which have come upon the premises subsequently to the first taking, if in the first instance he distrain all the goods then found thereon and for the entire rent, the amount of which exceeds the value of the goods first taken.

A distress for rent or other duties or services can be taken only between sunrise and sunset; but cattle or goods found damage-feasant may be distrained at any time of the day or night.

By the common law the remedy by distress was in general lost upon the death of the party to whom it accrued. But the king and corporations aggregate never die; and as the law authorises a surviving joint tenant to act as if he had been originally the sole owner, he may distrain for rent or other services accruing in the lifetime of his companion.

The statutes of 32 Hen. VIII. c. 37, and 3 & 4 Will. IV. c. 42, have extended the remedy by distress to husbands and executors in respect of rent accruing due to their deceased wives or testators. [RENT.]

No distress can be taken for more than six years' arrears of rent; nor can any rent be claimed where non-payment has been acquiesced in for twenty years, 3 & 4 Will. IV. c. 27.

V. *In what place a distress can be made.*—The remedy being given in respect of property, not of the person, a distress for rent or other service could at common law be taken only upon the land charged therewith, and out of which such rent or services were said to issue.

But this restriction did not apply to the king, who might distrain upon any lands which were in the actual occupation of his tenant, either at the time of the distress or when the rent became due.

The assumption of a similar power by other lords was considered oppressive, and it was ordained by the statute of Marlbridge, that no one should make distress for any cause out of his fee, except the king and his ministers thereunto specially authorised. The privilege of distraining in all lands occupied by the party chargeable, is communicated by 22 Car. II. c. 6; 26 Geo. III. c. 87; 30 Geo. III. c. 50; and 34 Geo. III. c. 75, to the purchasers of certain crown rents.

At common law if the tenant or any other person seeing the lord or his bailiff come to distrain for rent or other service, drove the cattle away from the land holden, they might be distrained off the land. Not so when the cattle without being driven went off before they were actually taken, though the lord or bailiff saw the cattle upon the land (which for some purposes is a constructive possession). Nor if after the view the cattle were removed for any other purpose than that of preventing a distress. On the other hand, cattle of which the lord or bailiff has no view whilst they are on the land, although the tenant drove them off purposely to avoid a distress, could not be distrained.

Under 8 Ann. c. 14, and 11 Geo. II. c. 19, where a lessee fraudulently or clandestinely carries off his goods in order to prevent a distress, the landlord may within five days afterwards distrain them as if they had still continued on the demised premises; provided they have not been (*bonâ fide*) sold for a valuable consideration.

And by the 7th section of the latter statute, where any goods fraudulently and clandestinely carried away by any tenant or lessee, or any person aiding therein, shall be put in any house or other place, locked up or otherwise secured, so as to prevent such goods from being distrained for rent, the landlord or his bailiff may, in the day time, with the assistance of the constable or peace officer (and in case of a dwelling-house, oath being also first made of a reasonable ground to suspect that such goods are therein), break open and enter into such house or place, and take such goods for the arrears of rent, as he or they might have done if such goods had been put in an open field or place.

To entitle the landlord to follow the goods, the removal must have taken place after the rent became due, and for the purpose of eluding a distress. It is not however necessary that a distress should be in progress, or even contemplated. Nor need the removal be clandestine. Although the goods be removed openly, yet if goods sufficient to satisfy the arrears are not left upon the premises, and the landlord is turned over to the barren remedy by action, the removal may be by a jury deemed fraudulent, and the provisions of these statutes will then apply. The goods of a stranger or of an under-tenant may be removed at any time before they are actually distrained upon, and cannot be followed.

Where two closes are let by separate demises and separate rents, though such demises be made at the same time, and are even contained in the same deed, a distress cannot be taken in one close for both rents.

If a rent-charge or rent-service also issue out of land which is in the hands or separate possession of two or more persons, a distress may be taken for the whole rent upon the possession of any one of them.

The lord may enter a house to distrain if the outer door be open, although there be other sufficient goods out of the house. It is not lawful to break open outer doors or gates; but if the outer door be open, an inner door may be forced. And where the lord having distrained is forcibly expelled, he may break open outer doors or gates in order to retake the distress. If a window be open, a distress within reach may be taken out at it.

At common law a distress might be taken for rent in a street or other highway being within the land demised. But now, by the statute of Marlbridge, private persons are forbidden to take distresses in the highway. This statute applies only to distresses for rent or for services, and not to toll. Nor does the statute make the distress absolutely void; for though the tenant may lawfully rescue cattle distrained in the highway, or may bring his action on the case upon the statute, yet if he brings trespass or replevin, it seems to be no answer to a justification or an avowry made in respect of the rent.

No rent can be reserved out of an incorporeal hereditament; and therefore at common law the lord could not distrain for rent in a place in which the tenant had merely an incorporeal right—as a right of common. By 11 Geo. II. c. 19, s. 8, landlords are enabled to take a distress for rent upon cattle belonging to their tenants feeding upon any common appendant or appurtenant to the land demised. But in cases not within this enactment, the rule of the common law applies; and therefore upon a demise of a wharf and the appurtenances, with liberty to land and load goods, the landlord cannot distrain the tenant's barges lying opposite and attached to the wharf.

VI. *Mode of making a distress.*—A distress may be made either by the party himself or his agent, and as distresses in manors were commonly made by the bailiff of the manor, any agent authorised to distrain is called a bailiff. The authority given to the bailiff is usually in writing, and is then called a warrant of distress; but a verbal authority, and even the subsequent adoption of the act by the party on whose behalf the distress is made, is sufficient. In order that the distrainee may know what is included in the distress, an inventory of the goods should be delivered, accompanied, in the case of a distress for rent, by a notice stating the object of the distress, and informing the tenant that unless the rent and charges be paid within five days, the goods and chattels will be sold according to law. This notice is required by 2 Will. & Mary, sess. 1, c. 5, s. 2, which enacts, "that where any goods shall be distrained for rent due upon any demise, lease, or contract, and the tenant or owner of the goods shall not, within five days next after such distress taken, and notice thereof with the cause of such taking, left at the chief mansion house, or other most notorious place on the premises, replevy the same, with sufficient security to be given to the sheriff,—that after such distress and notice and expiration of the five days, the person distraining shall and may, with the sheriff or under-sheriff, or with the constable of the place, cause the goods to be appraised by two sworn appraisers, and after such appraisement may sell the goods distrained towards satisfaction of the rent, and of the charges of distress, appraisement, and sale, leaving any surplus in the hands of the sheriff, under-sheriff, or constable, for the owner's use."

At common law, goods distrained were, within a reasonable time, to be removed to and confined in an enclosure called a pound, which is either a pound covert, that is, a complete enclosure, or a pound overt, an enclosure sufficiently open to enable the owner to see, and, if necessary, to feed the distress, the former being proper for goods easily removed or injured, the latter for cattle; and by 5 & 6 Will. IV. c. 59, s. 4, persons impounding cattle or animals in a common open or close pound, or in enclosed ground, are to supply them with food, &c., the value of which they may recover from the owner. By 11 Geo. II. c. 19, s. 10, goods distrained for any kind of rent may be impounded on any part of the tenant's ground, to remain there five days, at the expiration of which time they are to be sold, unless sooner replevied. The landlord is not however bound to remove the goods immediately after the expiration of the five days; he is allowed a reasonable time for selling. After the lapse of a reasonable time he is a trespasser if he retain the goods on the premises without the express assent of the tenant, which assent is generally given in writing.

The 1 & 2 Phil. and Mary, c. 12, requires that no distress of cattle be removed out of the hundred, except to a pound overt in the same county, not above three miles from the place where such distress is taken, and that no cattle or other goods distrained at one time be impounded in several places, whereby the owner would be obliged to sue out several replevins.

The 2 Will. & Mary, sess. 1, c. 5, s. 3, directs that corn, grain, or hay distrained be not removed, to the damage of the owner, out of the place where the same shall be found or seized, but be kept there until replevied or sold; and 11 Geo. II. c. 19, which gives a distress for rent-service upon growing crops, directs, ss. 8 and 9, that they shall be cut, gathered, and laid up, when ripe, in the barn or other proper place on such premises, or if none, then in some other barn, &c., to be procured for that purpose, and as near as may be to the premises, giving notice within one week of the place where such crops are deposited; and if the tenant, his executors, &c., at any time before the crops distrained are ripe and cut, pay or tender the rent, costs, and charges, the goods distrained are to be restored. In all other cases, if the rent or other duty be paid or performed, or tendered to be paid or performed before the distress is impounded, a subsequent detainer is unlawful, and a subsequent impounding or driving to the pound is a trespass.

The statutes authorising the sale of distresses extend only to those made for rent, and to those made for rates and other legal assessments. At common law distresses cannot in general be either sold or used for the benefit of the party distraining. But a distress for fines and amerciaments in a court leet, or for other purposes of public benefit, may be sold; and a special custom or prescription will warrant the sale of a distress in cases where the public has no immediate interest.

VII. *Rights and remedies of the distrainee.*—A distress made by a party who has no right to distrain, or made for rent or other service which the party offers to pay or perform, or made in the public highway, or upon goods privileged from distress either absolutely or temporarily, is called a *wrongful distress.* Where no right to distrain exists, or where the rent or duty is tendered at the time of the distress, the owner of the goods may rescue them or take them forcibly out of the possession of the distrainor, or bring an action of replevin, or of trespass, at his election. In replevin, the cattle or goods taken are to be re-delivered to the owner upon his giving security by a replevin bond, for returning them to the distrainor, in case a return shall be awarded by the court; and therefore, in this action, damages are recovered only for the intermediate detention and the costs of the replevin bond. [Replevin.] In the action of trespass, the plaintiff recovers damages to the full value of the goods; because, upon such recovery, the property in the goods is transferred to the defendant.

The 2 Will. & Mary, sess. 1, c. 5, s. 5, provides "That in case of any distress and sale for rent pretended to be due, where in truth no rent is due, the owner of the goods so distrained and sold may, by action of trespass or upon the case, recover double the value of such goods, with full costs of suit."

For a wrongful distress in taking goods protected by being in a street or highway, or goods privileged from distress, the remedy is by an action on the statute, in which the plaintiff is entitled to an immediate return as in replevin.

If the cattle or goods distrained cannot be found, the sheriff may take other cattle or goods in wither-nam (by way of counter-distress) of the same or of a different kind, belonging to the distrainor, and deliver them to the distrainee instead of his own.

Another species of wrongful distress is *re-caption*, or the taking of the same or other goods of the distrainee for the same causes pending an action of replevin, in which the legality of the first distress is questioned.

Wherever a distress is wrongful, the owner of the goods may rescue them from the distrainor; but after they are actually impounded, they are said to be in the custody of the law, and must abide the determination of the law.

Whether goods are rightfully or wrongfully distrained, to take them out of the pound is a trespass and a public offence. The proceeding by action is a more prudent course than making a rescue, even before an impounding, where any doubt exists as to the lawfulness of the distress. Independently of the danger of provoking a breach of the peace by the rescuer's thus taking the law into his own hands, he will be liable to an action for the injury sustained by the distrainor by the loss of the security of the distress, should the distress ultimately turn out to be lawful; and in such action, as well as in the action for pound-breach, the rescuer will be liable, under 2 Will. & Mary, sess. 1, c. 5, s. 4, to the payment of treble damages.

A distress for more rent, or greater services than are due, or where the value of the property taken is visibly disproportionate to the rent or other appreciable service, is called an *excessive distress*, for which the party aggrieved is entitled to recover compensation in an action; but he cannot rescue, nor can he replevy or bring trespass.

Upon a distress rightfully taken being afterwards irregularly conducted, the subsequent irregularity at common law made the whole proceeding wrongful, and the party was said to be a trespasser *ab initio*. But now, by 11 Geo. II. c. 19, where distress is made for rent justly due, and any irregularity or unlawful act is afterwards done by the party distraining, or his agent, the distress itself is not to be deemed unlawful nor the party making it a trespasser; but the person aggrieved by such irregularity, &c., may recover satisfaction for the special damage sustained. And see Bracton; Fleta; Coke upon Littleton; Bacon, Comyns, and Viner's 'Abridgments;' and Blackstone's 'Commentaries,' by Dr. Kerr.

DISULPHETHYLIC ACID. [Ethionic Acid].

DISULPHONAPHTHALIC ACID. [Naphthalic Group.]

DITCH. [Bastion.]

DITHIOBENZOLIC ACID ($C_{12}H_6N_2S_4O_{10}$, 2HO). A product of the action of sulphite of ammonia on dinitrobenzole. It is bibasic and cannot be isolated from its salts.

DITHIONIC ACID. [Sulphur, *Hyposulphurous Acid.*]

DITHYRAMBUS, the name of a hymn in honour of Dionysus, sung by a chorus of fifty men or boys as they danced round the blazing altar of the god; from this peculiarity it was also called the *cyclic* or *circling* chorus. The original subject of the song was the birth of

Dionysus, as the name seems to have implied. (Plato, 'Legg.' iii.) The music was Phrygian, and the accompaniment originally the flute. (Aristot., 'Polit.' viii. 7, 9.) The Dithyrambus is particularly interesting from the circumstance that Aristotle attributes to it the origin of the Greek tragedy. "Tragedy and comedy," says he ('Poet.' iv. 14), "having originated in a rude and unpremeditated manner, the first from the leaders in the Dithyrambic hymns, the other from the Phallic songs, advanced gradually to perfection." These leaders (ἐξάρχοντες), and not, as has been wrongly inferred from the words of Aristotle, the whole chorus, recited trochaic tetrameters, and are to be considered as the immediate predecessors of the actors. [DRAMA.] In the Appendix to Walker's Treatise on the Trilogy ('Nachtrag zur Schrift über die Æschylische Trilogie,' p. 228 and following), the reader will find a learned disquisition on the Dithyrambus, deformed however by some serious errors. After the leading properties of the Dithyrambus had merged in the Greek tragedy, it became very bombastic, and in the Greek, and even in modern languages, the epithet Dithyrambic is a synonym for turgid and hyperbolical expressions. The etymology of the word is unknown.

DIURETICS are agents which augment the urinary secretion and facilitate its expulsion from the bladder. They constitute an extensive class of substances which, however, are very uncertain in their action, and require to be varied very frequently on account of the effects which their long continued use produces on the stomach and digestive function. The uncertainty of their operation is owing probably less to causes inherent in them than to our want of acquaintance with or attention to the circumstances which influence their action. Some writers disavow their belief in the existence of a distinct class of substances entitled to be called diuretics, considering them as mere general stimulants; but such a view is inadmissible, as many of them, far from being stimulants, are decidedly sedative, while some of the feelings which cause diuresis, such as fear or terror, and the external application of cold, are likewise sedative in their effects on the system.

In attempting to ascertain or account for their mode of action, we must constantly bear in mind the nature of the functions of the kidneys, namely, not only to remove from the body a considerable quantity of its fluid contents, but at the same time a great number of saline and other principles, the retention of which, for any considerable time, in the system, causes serious departure from its healthy state, and in some instances speedy death. Not only therefore must the quantity of fluid eliminated be in due proportion, but the quality or chemical constitution of it must also be of a proper kind. Any variation in these conditions requires the interference of medicine to rectify it. In endeavouring to accomplish this object, it must be borne in mind that, according to the state of the system, sometimes an acid diathesis predominates, sometimes an alkaline. The means which we employ to attain our object may be classified according to their primary modes of action on the system. Some are stimulant, such as gamboge, cytisus scoparius, alcohol, spiritus ætheris nitrici, oil of juniper, oil of turpentine, &c. Some, again, are sedative, such as lactuca virosa, leontodon taraxacum, digitalis, squil, colchicum, &c.: others are refrigerant, of which some render the urine acid, such as the dilute mineral acids; some, on the opposite hand, render the urine alkaline, such as the carbonate of potass, acetate, tartrate and bitartrate of potass; while certain saline diuretics do not render it either acid or alkaline, such as nitrate of potass, biborate of soda, &c.

The more acrid diuretics seem to act upon the lower sphere of life, or what may be considered the vegetative system, such as the cellular tissue, the fatty structures, and the internal mucous coats, the secretion of which they render thinner as well as more abundant, but at the same time they interfere much with the assimilative process as well as with that of digestion, even when given in small doses; and hence arises the impossibility of prolonging their employment beyond a very limited time. Whatever be the agent we select it is by no means necessary that, to cause a diuretic effect, the substance should be decomposed; but it is important to remember that, when saline diuretics are decomposed, the alkali is carried to the kidneys as the emunctory by which it is to be ejected from the system, and hence their use speedily renders the urine alkaline, which, when in a high degree, may prove very hurtful to the system generally, and to the bladder and urinary passages in particular.

Numerous as are the agents termed diuretics, none of them will act as such unless the patient be under certain conditions. If a very inflammatory state of the system exist, no article will act as a diuretic till this be lessened, and hence the necessity of employing venesection and saline cathartics before administering any of the class of diuretics; and under such circumstances colchicum is perhaps the best to begin with. Even such inflammation as exists in some forms of dropsy must be removed by antiphlogistic means before diuretics will have a beneficial effect (Blackhall 'on Dropsy'); particularly after scarlatina, with albuminuria.

When a very great quantity of fluid is present in the body, some of it must be carried off by other means before diuretics can act, as the absorbents under such circumstances do not furnish a supply to the kidneys—the activity of absorption being always in an inverse ratio to the smallness of the quantity of fluid present. (Majendie.) If there be great general debility of the system, and particularly of the absorbents, this state must be obviated either by the exhibition of tonics previous to or along with the diuretic remedies. Lastly, none of the saline diuretics, which are susceptible of decomposition, will act, if any considerable catharsis be going on, and hence that action, if arising from other causes, should be moderated or checked; and care should be taken not to exhibit such of them as are also purgatives in such doses as to act upon the bowels. This observation is not intended to prohibit the exhibition of a single purgative previous to commencing the use of diuretics, as this is often beneficial, or to forbid their occasional use when required to obviate particular symptoms. It must never be forgotten that if the patient be kept very warm, the action will more probably be directed to the skin than to the kidneys; hence the patient should not, if possible, remain in bed: the medicines should be given during the day, and the air of the apartment should be cool, and the clothing light. Indeed cold itself is a powerful diuretic, and sometimes succeeds where every other fails. The drinking of diluents likewise promotes the action of the kidneys; it is therefore unwise as well as cruel to withhold water from dropsical patients. [DILUENTS.]

The wines of the Rhine, Maine, and above all, of the Moselle, are powerful diuretic drinks, and their use tends much to diminish the liability to stone in the bladder. (Liebig.) [WINE.] But to do good, these wines should mostly be used habitually—and alone, not mixed or alternated with other wines.

Diuretics are by no means sufficiently employed as general curative agents, particularly in chronic diseases. In many cutaneous diseases of an obstinate kind they are very valuable; the vicarious nature of the functions of the skin and the kidneys pointing the one out as the appropriate substitute for the other.

DIVAN or DIWÂN, is a Persian word familiar to readers of works relating to the East, in the sense of—1st, a senate, or council of state; and, 2nd, a collection of poems by one and the same author. The earliest acceptation, however, in which we find it employed is that of a muster-roll, or military pay-book. The Arabic historian, Fakhreddin Râzi informs us that when, in the caliphat of Omar, the second successor of Mohammed, the conquests of the Mussulmans assumed an extensive character, the equal distribution of the booty became a matter of great difficulty. A Persian marzbân, or satrap, who happened to be at the head-quarters of the caliph at Medinah, suggested the adoption of the system followed in his own country, of an account-book, in which all receipts and disbursements were regularly entered, along with a list duly arranged, of the names of those persons who were entitled to a share in the booty. With the register itself, its Persian appellation (dîwân) was adopted by the Arabs. (Freytag, 'Locmani Fabulæ et plura loca ex codd. historicis selecta,' &c., pp. 32, 33; Henzi, 'Fragmenta Arabica,' St. Petersburg, 1828, p. 36, *et seq.*) Whether a council of state was subsequently called divan, as having originally been a financial board appointed to regulate the list (dîwân) of stipendiaries and pensioners, or whether it was so called as being summoned according to the list (dîwân) containing the names of all its members, we are unable to determine. The opinion that a body of councillors should have received this appellation, as has been asserted by some, in consequence of the expression of an ancient king of Persia, *înân dîwân end*, "these (men) are (clever like) devils," will scarcely be seriously entertained by any one. The word "dîwân" is also used to express the saloon or hall where a council is held, and has been applied to denote generally a state chamber, or room where company is received. Hence probably it has arisen that the word "divan," in several European languages, signifies a sofa. The divan of the present empire of Turkey consists of the grand vizir, or prime minister; the grand mufti, or head of the church; the seraskier pasha, or minister of war; the tyrdji pasha, commander of the artillery; the capudan pasha, commander of the navy; the reis effendi, or oumouri kharjieh naziri, minister for foreign affairs; the kiaya bey, or oumouri milkieh naziri, minister of the interior; the three ministers of finance, commerce, and police; the president of the council; the master of the mint; and the comptroller general of ecclesiastical property. Each of these dignitaries bears the title of mushir.

Collections of poems in Persian, Arabic, Turkish, Hindustani, &c., seem to have received the appellation "dîwân" from their methodical arrangement, inasmuch as the poems succeed one another according to the alphabetic order of the concluding letters of the rhyming syllables, which are the same in all the distichs throughout each poem.

DIVERGENCY, DIVERGENT. [CONVERGENT.]

DIVIDED EYE-GLASS MICROMETER. [MICROMETER.]

DIVIDEND, in arithmetic, any quantity which is to be divided (*dividendum*). Thus, in the sentence "100 divided by 20 gives 5," the dividend is 100.

DIVIDEND, in commerce, is a word having two distinct meanings. In its more general employment, it is understood to express the money which is divided, *pro rata*, among the creditors of a bankrupt trader, out of the amount realised from his assets. [BANKRUPT.]

The other meaning attached to the word dividend is not so appropriate as that which has just been explained. It is used to signify the half-yearly payments of the perpetual and terminable annuities which constitute the public debt of the country, and does not therefore strictly express that which the word is made to imply. The payment of those so-called dividends is managed on the part of the government by the Bank of England, which receives a compensation from the public for the trouble and expense attending the employment.

DIVIDING ENGINE. [GRADUATION.]

DIVING-BELL. Much ingenuity has been devoted from an early period to the contrivance of apparatus for enabling men to dive, or descend beneath the surface of water, to a greater depth, for a longer space of time, and with less exertion and danger, than is possible by the unassisted powers of the body. The fatal consequences of continued submersion are described under ASPHYXIA and DROWNING; and from the facts there stated it is evident that about half a minute is the longest period during which most individuals can safely remain under water, without some provision for the supply of air for respiration. Experienced divers may remain under water much longer, though not without great and painful exertion; but the longest period of submersion, with a few extraordinary exceptions, does not exceed two minutes; a space of time too brief to allow the performance of any but the simplest operations beneath the surface of the water. The pearl-fishery affords the most prominent example of the employment of divers unassisted by apparatus for providing a supply of air. The mode of diving adopted, and the effects of protracted submersion upon the divers, are described under PEARL FISHERY. Professor Beckmann alludes to the employment of divers in ancient times to assist in raising anchors, in recovering goods from wrecks, or such as had been thrown overboard in times of danger, and in destroying the works and ships of the enemy in time of war, as well as in fishing for pearls; but some of the statements quoted by him are evidently much exaggerated, as they speak of divers remaining for hours under water. Six minutes is about the longest time of submersion of which any authentic account has appeared in modern times. [PEARL FISHERY.]

Dr. Halley, in a paper printed in No. 349 of the 'Philosophical Transactions' (vol. xxix., p. 492), entitled 'The Art of Living under Water,' observes that the divers for sponges in the Archipelago were accustomed to take down in their mouths a piece of sponge soaked in oil, by which they were enabled to dive for a longer period than without it. As the bulk of the sponge must diminish the quantity of air which the diver could contain in his mouth, it does not appear probable that this practice could assist respiration.

In connection with diving by the unassisted powers of the body, allusion may be made to a curious and important fact related in the 'Encyclopædia Britannica,' on the authority of Professor Faraday, to whom it was first noticed by a gentleman connected with the Asiatic Society. The lungs are, in their natural state, charged with a large quantity of impure air; this being a portion of the carbonic acid gas which is formed during respiration, but which, after each expiration, remains lodged in the involved passages of the pulmonary vessels. By breathing hard for a short time, as a person does after violent exercise, this impure air is expelled, and its place is supplied by pure atmospheric air, by which a person will be enabled to hold his breath much longer than without such precaution. The writer states that although he could only hold breath, after breathing in the ordinary way, for about three quarters of a minute, and that with great difficulty, he felt no inconvenience, after making eight or ten forced respirations to clear the lungs, until the mouth and nostrils had been closed more than a minute and a half; and that he continued to hold breath to the end of the second minute. A knowledge of this fact may in many cases be of great importance, as it may enable a diver to remain under water at least twice as long as he otherwise could do. It is suggested that possibly the exertion of swimming may have the effect of occasioning the lungs to be cleared; so that persons accustomed to diving may unconsciously avail themselves of this preparatory measure.

Another important fact, related in the same work, indicates the advantage of breathing condensed air, and thereby obtaining a larger supply of oxygen in the same bulk than with air of the ordinary pressure. After one of the disastrous occurrences at the works of the Thames Tunnel, Mr. Brunel, the engineer, descended in a diving-bell to examine the breach made by the irruption of the river into the tunnel. The bell descended to the mouth of the opening, a depth of about thirty feet; but the breach was too narrow to allow it to go lower, in order that the shield and other works, which lay eight or ten feet deeper, might be examined from the bell. Brunel therefore took hold of a rope, and dived below the bell for the purpose. After he had remained under water about two minutes, his companion in the bell became alarmed, and gave a signal which occasioned Brunel to rise. On doing so he was surprised to find how much time had elapsed; and, on repeating the experiment, he ascertained that he could with ease remain fully two minutes under water; a circumstance accounted for by the condensation of the air in the bell, from which his lungs were supplied, by the pressure of a column of water nearly thirty feet high, which would condense the air into little more than one half of its usual bulk.

Many plans were suggested for enabling persons to remain for a longer period under water than is possible by the natural powers of the body, long before extensive use was made of any of them. Beckmann alludes to a passage of Aristotle (problem xxxii., § 5), which has been supposed to intimate that in his time divers used a kind of kettle to enable them to continue longer under water; but this passage is variously rendered by different translators, and Beckmann appears to place little reliance upon it. He states that the oldest information we have respecting the use of the diving-bell in Europe is that of John Taisnier, quoted by P. Gaspar Schott. It occurs in the 'Technica Curiosa, sive Mirabilia Artis,' &c., of Schott, which was published at Nürnberg, in 1664, lib. vi., cap. ix., p. 393, and is taken from the 'Opusculum de Motu Celerrimo' of Taisnier, who says, "Were the ignorant vulgar told that one could descend to the bottom of the Rhine, in the midst of the water, without wetting one's clothes or any part of one's body, and even carry a lighted candle to the bottom of the water, they would consider it as altogether ridiculous and impossible. This, however, I saw done at Toledo in Spain, in the year 1538, before the emperor Charles V. and almost ten thousand spectators. The experiment was made by two Greeks, who, taking a very large kettle suspended by ropes with the mouth downwards, fixed beams and planks in the middle of its concavity, upon which they placed themselves, together with a candle. The kettle was equipoised by means of lead fixed round its mouth, so that when let down towards the water no part of its circumference should touch the water sooner than another, else the water might easily have overcome the air included in it, and have converted it into moist vapour." * Schott calls the machine described, "Cacabus aquaticus," or an "aquatic kettle;" but he also describes an apparatus called "Lorica aquatica," or "aquatic armour," which would enable those who were covered with it to walk under water, and which he seems to prefer to the "cacabus aquaticus" previously described.† This apparatus is represented in plate 31 of Schott's work, which shows a man walking into the water with a covering like a small diving-bell over his head, descending nearly to his feet.

In England, without noticing the supposed contrivance of a diving-machine by Roger Bacon, it is evident that the diving-bell was known at an early period. It is mentioned by Lord Bacon ('Novum Organum,' lib. ii. § 50; and 'Phænomena Universi,' p. 702) as a machine used to assist persons labouring under water upon wrecks, by affording a reservoir of air to which they might resort whenever they required to take breath.

Some curious information on submarine operations is given in the postscript to a little volume published at Edinburgh, in 1688, by George Sinclar, "sometime Professor of Philosophy in the College of Glasgow," entitled 'The Principles of Astronomy and Navigation.' The postscript contains an account of how "to buoy up a ship of any burden, from the ground of the sea," and states that among those who had, in this nation, attempted to recover property from wrecks by diving, was the late Marquis of Argyle, "who having obtained a patent from the king, of one of the Spanish Armada, which was sunk in the Isle of Mull, anno 1588, employed James Colquhoun, of Glasgow, a man of singular knowledge and skill in all mechanical arts and sciences." "This man," he proceeds, "not knowing the diving-bell, went down several times, the air from above being communicated to his lungs by a long pipe of leather. He only viewed and surveyed the ship, but I suppose buoyed nothing up." Sinclar subsequently states that about 1664, the (then) late Lord Argyle employed an ingenious gentleman, the laird of Melgim, who went down with a diving-bell and got up three guns. A third and more successful trial was made, he says, several years after; and, still later, one Captain Smith was so confident of obtaining the gold supposed to be lost with the ship, that he would not admit a co-partner in the enterprise; which, however, came to nothing. Sinclar proposed to raise wrecks by the buoyancy of arks or boxes, open at the bottom, which were to be sunk full of water, and then filled with air either by sending down casks of air; by bellows and a long tube; or otherwise. He alludes to the occasional use of casks for the purpose of raising vessels, and explains why, when at a great depth, they are liable to be crushed by the pressure of the water, showing that, by allowing the water to enter by a hole in the lower part of the cask, it would so compress the air as to produce an equilibrium of pressure, and thereby preserve it from fracture. About the time that the work above quoted was published, William Phips, who subsequently became governor of New England, attempted to raise treasure from the wreck of a Spanish ship sunk on the coast of Hispaniola. What was the precise character of his apparatus, we are not informed. His earliest experiments failed, but he was so confident of success, that he sought for assistance to enable him to prosecute his scheme. He at length obtained the patronage of the Duke of Albemarle, son of the celebrated Monk, and in 1687, after many difficulties, he succeeded in raising a large quantity of treasure, with which he returned to England; where he was honoured with knighthood for his enterprise. Most accounts state that the property he recovered amounted to 200,000*l.*; but in the 'Life of Sir William Phips,' published anonymously in 1697, but attributed to Increase Mather, it is stated as 300,000*l.* It is unnecessary to cite further instances of the use of diving apparatus, or to notice other early authors who have mentioned the diving-bell, except to observe that Beckmann alludes to engravings in editions of Vegetius on the art of war, published in 1511 and 1532, representing a diver with a cap, from which rises a long leathern pipe, terminating in an opening which floats upon the surface of the water; and to a figure published in a work on fortification, by Lorini, in 1607, which nearly resembles the modern diving-bell. Beckmann considers the insertion of the former as a proof that the person who drew them was not acquainted with the diving-bell, which he would otherwise have delineated. The machine described by Lorini consists of "a square box bound round with iron, which is furnished with windows, and has a stool affixed to it for the diver." Lorini, who was an Italian, does not lay claim to the invention of this apparatus.

---

* We quote from the translation in the English edition of Beckmann's 'History of Inventions,' by William Johnstone, second edition, 1814, vol. i., p. 184.

† His words are: "Longe melior est alia illa, quam ex Francisco Köslero proponit *Daniel Schvventerus* in Deliciis Mathematicis," Part 12, prop. 15.

Dr. Halley, in No. 349 of the 'Philosophical Transactions,' (vol. xxix.) describes the defects of the diving-bell, as previously used, and suggests a remedy for them. This paper alone would be sufficient, although it does not enter into the early history of the machine, to contradict the erroneous statement which has been made to the effect that Halley was the inventor of the diving-bell.

In its simplest form the diving-bell is a strong heavy vessel of wood or metal, made perfectly air and water tight at the top and sides, but open at the bottom. If such a vessel be gradually lowered into the water, in a perfectly horizontal position, the air which it contains cannot escape, and therefore the vessel cannot become full of water. This may be readily illustrated by plunging a glass tumbler, in an inverted position, into a vessel of water, and placing a bit of cork, or any other substance which will float, on the surface of the water, under the glass. If a bit of burning matter be laid upon the cork-float, it will be seen that it continues burning, although the glass and all that it contains be plunged far beneath the water; thereby proving that the upper part of the cavity of the glass is occupied by air, and not by water. In this experiment, however, it will be observed that the water does fill a small part of the cavity of the glass, and that it rises more into it when it is plunged to a considerable depth than when the rim is only just immersed beneath the surface. This is occasioned by the condensation of the air contained in the glass, which being very elastic and compressible, is condensed into a smaller space by the pressure of the superincumbent water, when the glass is plunged to a considerable depth, than it will occupy under the ordinary pressure of the atmosphere. Where the diving-bell is used for descending to a very small depth, as the pressure of the water is small, it will not rise in the bell to a sufficient height to be inconvenient; but at the depth of 33 feet the pressure is so great as to compress the air into one-half its original volume, so that the bell will become half full of water; and at a greater depth the air will be still more compressed, and the water will rise proportionately higher in the bell. This condensation of the air does not materially interfere with respiration, provided the descent of the bell be very gradual, as the air then insinuates itself into the cavities of the body and balances the pressure from without. The principal effect of the increased pressure is a pain in the ears, occasioned by the circumstance that the Eustachian tube does not allow the condensed air immediately to find its way into the cavities of the ear, so that the pressure on the outside of the tympanum is, for a time, unbalanced by a corresponding pressure from within, and occasions a sensation like that of having quills forced into the ears. This continues until the pressure of the air in the mouth, which at first has a tendency to keep the aperture of the Eustachian tube closed, forces it open; an action which is accompanied by a noise like a slight explosion. The condensed air then enters the interior cavities of the ear, and, by restoring the equilibrium of pressure on each side of the tympanum, removes the pain; which will return, and be remedied in the same manner, if the bell should descend to a greater depth. But while the mere condensation of the air in the bell does not render it unfit for respiration, it would soon become so if no means were provided for renewing it from time to time, as it becomes vitiated by repeated respiration. The improvements invented by Dr. Halley provided a remedy for this inconvenience, and for that of the contracted space left free from water, when, by being at a great depth, the air is compressed into a small volume, by affording a convenient means of supplying the bell with any required quantity of fresh air, without raising it to the surface.

The bell used by Dr. Halley was of wood, in the form of a truncated cone, 5 feet in diameter at the bottom, and three feet at the top, and containing about sixty cubic feet. This was coated with lead, and so weighted about the lower part that it would sink while empty, and would always remain in its proper position; that is, with the large open end downwards, with its rim parallel with the horizon. In the top of the bell was a very strong glass window, and a cock, by opening which the foul air might be allowed to escape. About a yard below the mouth of the bell was suspended a stage, so weighted that it might hang steadily. The whole apparatus was suspended from a sprit attached to the mast of a ship, and provided with tackle by which the bell might be raised or lowered, and the sprit might be slung round so as either to carry the bell over the hull of the vessel, or to suspend it clear of her side. The apparatus for conveying air to the diving-bell consisted of two barrels, holding thirty-six gallons each, weighted with lead to make them sink readily. Each of these had an open bung-hole in the lower end, to allow water to enter during their descent, so as to condense the air in the manner described when explaining the principles of the diving-bell itself. There was also a hole in the upper end of each, to which was fitted an air-tight leathern hose, long enough to fall below the bottom of the barrel, and having its loose end so weighted that it would fall naturally into that position. These air-barrels were attached to tackle, by which, with the easy labour of two men, they might be made to rise and fall alternately, like two buckets in a well; and, by lines attached to the lower edge of the bell, they were so guided in their descent that the mouth of the hose always came directly to the hand of a man who stood upon the stage suspended from it. As the apertures of the hose were, during their descent, always below the level of the barrels, no air could escape from them; but when they were turned up by the attendant, so as to be above the level of the water in the barrels, the air rushed out with great force into the bell, the barrels becoming at the same time full of water. By sending down these air-barrels in rapid succession, the air in the barrel was kept in so pure a state that five persons remained in the bell, at a depth of nine or ten fathoms, for more than an hour and a half at a time, without injurious consequences; and Halley states that he could have remained there as long as he pleased, for anything that appeared to the contrary. In addition to this, by the copious supply of air admitted during the descent, the bell was kept constantly full of air, and the water was prevented from entering to any inconvenient extent. Halley observed that it was necessary to be let down gradually at first, and to pause at the depth of about twelve feet, to drive out, by the admission of a supply of air, the water which had entered the bell. When the diving-bell was arrived at the required depth, he let out, by the cock in the top of the bell, a quantity of hot impure air, equal to the quantity of fresh air admitted from the barrels. This foul air rushed up from the valve with such force as to cover the surface of the sea with a white foam. So perfect was the action of this apparatus, that Halley says he could, by removing the hanging stage, lay the bottom of the sea so far dry, within the circuit of the bell, as not to be over shoes thereon. When the sea was clear, and especially when the sun shone, sufficient light was transmitted to allow a person in the bell to write or read; and when the sea was troubled and thick, which occasioned the bell to be as dark as night, a candle was burnt in it. Halley sometimes sent up orders with the empty air-barrels, writing them with an iron pen on plates of lead. Having, by these ingenious contrivances, removed the principal difficulties attending the use of the diving-bell, Halley foresaw its extensive utility. He observes, "This I take to be an invention applicable to various uses, such as fishing for pearl, diving for coral, sponges, and the like, in far greater depths than has hitherto been thought possible. Also for the fitting and plaining of the foundations of moles, bridges, &c., upon rocky bottoms; and for the cleaning and scrubbing of ships' bottoms when foul, in calm weather at sea." "But," he adds, "as I have no experience of these matters, I leave them to those that please to try." To several of these purposes the diving-bell has, since the date of this paper (1717), been applied with great advantage.

In 1732 a communication was made to the 'Philosophical Transactions,' No. 444, vol. xxxix., p. 377, by Martin Triewald, "Captain of Mechanics, and military architect to his Swedish majesty," respecting an improvement of the diving-bell. He had the sole privilege of diving upon the coasts of the Baltic belonging to the king of Sweden; and he expresses his opinion, founded on much experience, that no apparatus but that on the principle of the "campana urinatoria," or diving-bell, could be safely used at great depths. His letter mentions a man, then sixty-three years old, who had followed the business of diving with the common diving-bell ever since he was twenty. Triewald's diving-bell was of copper, tinned inside, smaller than that of Dr. Halley, and managed by two men. A stage for the diver to stand upon was suspended at such a depth below it, that the man's head would be but little above the level of the water, where the air is cooler and fitter for respiration than in the upper part of the bell; and a spiral tube was attached to the inside of the bell, with a wide aperture at the bottom, and a flexible tube and mouth-piece at the top, so that, when the diver was up in the bell, he might inhale cool air from the lower part, exhaling the foul air by his nostrils. Dr. Halley's air-barrels are applicable to a bell of this construction. In lieu of windows of flat glass, Triewald used convex lenses to admit light to the bell.

In 1775 Mr. Spalding, of Edinburgh (who, according to the 'Annual Register,' vol. xix., p. 202, was a grocer), having some concern in a vessel which had been lost on the Fern Islands, was induced to make some experiments with Dr. Halley's diving-bell, with a view to recovering property from wrecks, and was thereby led to the invention of means for rendering it more safe and manageable. For these inventions he received, in 1776, a reward of twenty guineas from the Society for the Encouragement of Arts, Manufactures, and Commerce, in the first volume of whose 'Transactions' (pp. 220-238) they are fully described. Mr. Spalding's communication contains also a very interesting account of his experiments with Halley's diving-bell. The improved diving-bell contrived by Mr. Spalding was made so light, that, with the divers and the weights attached to the rim, it would not sink; the weight necessary to counteract its buoyancy being added in the form of a large balance-weight, suspended from its centre by a long rope, which was so mounted on pulleys that the divers could either draw the balance-weight up to the mouth of the bell or allow it to fall to a considerable depth below it. Thus, by letting the weight down to the bottom, the divers could, as it were, anchor the bell at any required level; or prevent its further descent if they perceived a rock or part of a wreck beneath it, which might otherwise overturn it.

Also, by hauling in the rope while the weight was at the bottom, the persons in the bell might lower themselves at pleasure. Another improvement consisted in the addition of a horizontal partition near the top of the bell, which divided off a chamber that might, by suitable openings and valves, be filled either with water, or with air from the lower part of the bell; so as to alter the specific gravity of the whole machine, and thereby to cause it to ascend or descend at pleasure. The bell was supplied with air by an apparatus resembling that of Dr. Halley; and ropes, stretched across the bell, were used instead of seats and platforms for standing on. By these arrangements the persons in the diving-bell were enabled, in case of accident, to raise themselves to the surface without any assistance from above; and it was rendered so perfectly manageable, that it might be removed to a considerable distance from the point at which it descended; its outward motion, and its return to the vessel for the purpose of being hauled up, being assisted by a longboat, which carried the signal-lines and the tackle for working the air-barrels.

Though not in chronological order, it may be well here to allude to an improvement upon Spalding's apparatus, contrived by Mr. John Farey, junior, and described by him in the article 'Diving-Bell,' in Brewster's 'Edinburgh Encyclopædia.' He proposes to make the upper chamber of the diving-bell very strong and air-tight, without any openings for the admission of water. In the partition are fixed two forcing-pumps, by which a portion of air should be forced into the upper chamber, whenever, during a pause in the descent, the lower chamber, or the cavity of the bell, is replenished with air. By this means the upper chamber is made a reservoir of condensed air, from which the bell may be replenished with air when it is desired to increase its buoyancy by forcing out the water from the lower part. In like manner, the buoyancy of the bell can be at any time diminished by pumping some of the air from it into the upper chamber, whereby the water will be allowed to enter to a greater height; and, as this is effected without wasting the air, there is no danger of diminishing the buoyancy of the machine to a degree which would prevent it from rising in case the suspending rope or chain should break. Mr. Farey recommends the form of the frustum of an elliptic cone, for diving-bells intended for descending to wrecks; the dimensions being, for a bell to hold two persons, 6 feet by 4 at the base, 3 feet 6 inches by 2 feet 6 inches at the top, and 6 feet 6 inches high. He also suggests the use of a pressure-gauge in the bell, to show the divers what depth they have descended to; and of a compass to enable them to ascertain and give proper signals respecting the direction in which the bell should be moved. These signals are given by snatching a rope, which may be marked in the same manner as a deep-sea lead-line [SOUNDINGS], so that, after giving a signal to raise or lower the bell, the diver may, by hauling in a certain quantity of the signal-line, intimate the height to which the bell should be moved. Farey recommends that the men be attached by ropes to the bell, so that in case of falling, they may not sink; and that, in case of being obliged to leave a wreck to which it is intended again to dive, the balance-weight may be left at the bottom, with a buoy attached to the upper end of its rope, so that the right point for descending may be found without difficulty.

The credit of having been the first to apply the diving-bell in aid of civil engineering operations is usually attributed to Smeaton, who used it in 1779 in repairing the foundations of Hexham Bridge. The Report in which he recommended its adoption is a very interesting document, as it affords a familiar explanation of the principle of the diving-bell. It is dated September 16, 1778; and is printed in the collected edition of his 'Reports,' vol. iii., p. 279. The bell used on this occasion was an oblong box of wood, 4 feet high, 2 wide, and 3½ long; and it was supplied with air by a pump fixed on the top. The river being shallow, the bell was not covered with water; but in 1788 the diving-bell was used in a much more important work, Ramsgate harbour, by the same engineer. Being here used at a considerable depth, an apparatus was employed for forcing in a supply of air through a flexible pipe, by means of a forcing-pump in a boat. The bell used in this work was of cast-iron, similar in form to that employed at Hexham, but 4½ feet high, 4½ long, and 3 wide. Its weight was fifty cwt., and the thickness was so adjusted that it would, without the addition of any weights, sink in the proper position. In levelling foundations under water by this machine, the surface of the water at the bottom of the bell formed a convenient and unerring level to work to; and in this, as well as in the subsequent operation of building, every necessary motion was given to the bell by the tackle by which it was suspended; signals being made from below by striking one, two, three, or more blows upon the side of the bell with a hammer.

Since the time of Smeaton the diving-bell has been frequently, and with great advantage, employed in submarine works; sometimes in situations in which it would have been impossible to construct a coffer-dam, or to perform the required operations by any other means. The diving-bells used in such works are usually formed on the model of that made for the works at Ramsgate harbour; but the mode of suspension differs according to circumstances. The bell may be suspended over the side or end of a vessel; through an opening in the centre of a barge; from frame-work resting upon two barges, placed parallel with each other, but at such a distance apart as to allow the bell to descend between them, or from a scaffolding supported by piles. In operations at the harbour of Howth, near Dublin, the late Mr. Rennie used a diving-bell suspended from a kind of railway scaffolding like that described under SCAFFOLDING, as used in erecting large stone buildings; two carriages being used upon the scaffold, one to lower the stones, and the other to manage the bell. By the apparatus described as above, aided by ropes attached to the stones, and managed by the men in the bell, the submarine masonry could be executed with great facility. Of the use of this important machine in recovering property from wrecks, the operations upon that of the Royal George afford a familiar example. According to the 'Annual Register,' vol. lix., p. 42, this wreck was first surveyed by the diving-bell on the 24th of May, 1817. Smeaton's method of supplying air to the bell is that most commonly employed; but that of Halley may, in some cases, have the advantage.

The diving-bell, with some slight modifications in the details of the pumps, and of the hoisting and lowering apparatus, continues to be used in the execution of hydraulic masonry of a difficult and delicate nature; and occasionally, as in the execution of the harbour of refuge of Dover, for the purpose of raising the huge masses of masonry in the jetties carried out into deep water.

In whatever way a diving-bell may be mounted, it is essential that it should descend very gradually, and that its descent should be perfectly under control. In 1838, Mr. Richard Jones, who had been placed in a very perilous situation by the failure of the crab by which a diving-bell in which he was descending was being lowered, was rewarded by the Society of Arts for a contrivance to prevent the occurrence of such an accident. His improved crab has a brake, regulated by the centrifugal motion of two balls, like the governor of a steam-engine; so that, while the crab revolves slowly, and therefore allows the bell to descend gradually, the brake may not be called into action; but if it should, from any cause, be overpowered by the weight of the bell, so as to run down with dangerous velocity, the separation of the balls should disengage the brake, and thereby stop the motion of the crab. The machine is described and represented in detail in vol. lii., p. 72, &c. of the Society's 'Transactions.'

Of late years a system, originally suggested by Coulomb in 1788, of executing masonry, or other hydraulic works, at great depths from the surface, has been used with considerable success at the Rochester and the Saltash bridges. In these cases the foundations were laid without coffer-dams, by means of air-tight chambers in which the workmen laboured in an atmosphere of condensed air. An account of the machinery used at Rochester bridge was printed by Mr. Hughes, who conducted the works; and a description of an analogous operation executed at Croissac, in France, has been given by M. de la Gournerie in the 'Annales des Ponts et Chaussées' for 1848. The cylinders used by Dr. Potts have a distant connection with this class of operations, but it will be more convenient to notice the whole subject more in detail under the article FOUNDATION.

Many plans have been proposed for enabling a man to walk beneath the surface of water, or to dive in such a manner as to assist in the raising of anchors, or the recovery of property from wrecks, by means of waterproof coverings for the head and upper part of the body, or of strong vessels in which every part but the arms should be encased; a supply of air being either transmitted from above by a flexible pipe, or contained in the cavities of the protecting armour. Such apparatus may be conveniently used at small depths; but at any considerable depth they are both dangerous and inconvenient, because the strength necessary to enable them to bear the pressure of the water is incompatible with the flexibility essential to the free use of the limbs. Dr. Halley alludes, in his paper on the diving-bell, to some contrivances of this kind; and in a subsequent paper ('Phil. Trans.,' No. 368, vol. xxxi., p. 177) he describes an apparatus of his own invention, by which a man might leave the diving-bell, and walk about at the bottom of the sea; his head being covered by a heavy leaden cap like a small diving-bell, supplied with air by a flexible tube extending from the large bell. The diver was to coil this tube round his arm, and unwind it as he left the bell, and to use it as a clue to direct him to the bell in returning. This pipe was formed of leather soaked in oil and hot wax, and was held open by a spiral coil of brass wire, its internal diameter being about one-sixth of an inch. The pipe was then covered with several thicknesses of gut, and over all with leather. The modern invention of waterproof India-rubber cloth, which has been applied in various ways to diving apparatus, affords great facilities for the manufacture of water-tight tubes for such a purpose. So long as the helmet was above the level of the water in the bell, it would be kept full of air; and in case of having to stoop below that level, as in getting out of or into the bell, the diver had only to close a valve, by which the air in the helmet was prevented from returning into the bell. The front of the helmet was glazed; and the diver, who was clothed in a thick woollen dress, fitting close to the body, to diminish the effect of the coldness of the water, was enabled to walk by means of a weighted girdle and weighted clogs. Aquatic armour, whether supplied with air from above, or carrying a store in its cavities sufficient to last for the time the diver intends to remain submerged, has been brought so little into use that it is needless to devote the space required for a minute description. The apparatus of M. Klingert, which was first described in a pamphlet published at Breslau in 1798, has been fully explained in Tilloch's 'Philosophical Magazine' (vol. iii., pp. 59 and 171), and in many other English works; and a more recent contrivance of similar character has been exhibited at the Polytechnic Institution, London. In the 'Gentleman's Magazine' for September, 1749 (vol. xix., p. 412), will be found a notice of a curious diving apparatus, consisting of a case inclosing the person, with the arms protruding in flexible sleeves, which is stated to have been contrived and used for many years by a person named John Lethbridge, who writes from Newton Abbot, near Exon, Devon, and states that he tried experiments as early as 1715. This was supplied with air by flexible pipes. A similar machine was contrived by Mr. Rowe in 1753, which was to be lowered by tackle like a diving-bell.

One of the diving-machines contrived by Klingert was so arranged that it would rise or fall by the motion of a piston in a cylinder, in the lower part of the apparatus, by which the diver could vary the density of the air, and consequently the specific gravity of the machine, at pleasure. A very simple apparatus for enabling a person diving without a bell, or any of the machines above noticed, to effect the same object, has been recently invented by Mr. W. H. Thornthwaite of Hoxton. It is described in the fifty-second volume (p. 243) of the 'Transactions' of the Society of Arts, by whom Mr. Thornthwaite was rewarded for it in 1839. It consists of a hollow belt of India-rubber cloth, to which is attached a small but strong copper vessel. Into this vessel air is to be forced by a condensing syringe, until it has a pressure of thirty or forty atmospheres. The belt is then put on, in a collapsed state, so that it affords no buoyancy, and does not impede the descent of the diver; but when he desires to rise, he opens a valve, by which the condensed air escapes from the copper vessel into the belt. As it expands the belt, it affords sufficient buoyancy to raise the diver immediately to the surface.

An account of schemes for submarine descent would hardly be complete without some allusion to projects for submarine navigation, of which many have been suggested. An early instance is that of Cornelius Drebell, or Drebelle, who is said to have made a vessel to be rowed under water, which was tried in the Thames by order of James I., and carried twelve rowers, besides passengers. This vessel is alluded to by Robert Boyle, in his 'New Experiments Physico-Mechanicall, touching the Spring of the Air, and its effects,' &c., published at Oxford in 1660. Pages 363-5 of this curious work contain an account of Drebell's experiment, and state that he accounted his chief secret to be "the composition of a liquid that would speedily restore to the troubled air such a proportion of vital parts as would make it again, for a good while, fit for respiration." The composition of this liquid for enabling the same air to be used again and again, was never made public. Bishop Wilkins, who also favoured some other whimsical projects, devoted a whole chapter of his 'Mathematicall Magick,' which was published in 1648, to a dissertation 'Concerning the possibility of framing an Ark for Submarine Navigation.' In this work (book ii., chap. 5) he recites the difficulties of the scheme, but evidently considers them not insurmountable; and afterwards he enlarges upon its advantages, in privacy, security from pirates, storms, ice, &c., in naval warfare, philosophical experiments, discoveries, &c., and at length states that "All kind of arts and manufactures may be exercised in this vessel. The observations made by it may bee both written and (if need were) printed here likewise. Severall Colonies may thus inhabit, having their children born and bred up without the knowledge of land, who could not chuse but be amazed with strange conceits upon the discovery of this upper world." The bishop adds, "I am not able to judge what other advantages there may be suggested, or whether experiment would fully answer to these notionall conjectures." In 1774 a projector named Day lost his life in an experimental descent in Plymouth Sound, with a vessel of about 50 tons burden, which he thought he could have caused to rise after a lapse of several hours; and this experiment, of which an account is given in the seventeenth volume of the 'Annual Register' (p. 245), led to the publication, in the following year, of a 'Philosophical Dissertation on the Diving Vessel projected by Mr. Day, and sunk in Plymouth Sound,' by N. D. Falck, M.D., which contains a representation and minute description of the vessel, an account of the ineffectual attempts to raise her, and much other curious matter. One of the most successful machines contrived for submarine navigation was that of Mr. Bushnell of Connecticut, which was projected in 1771, and completed in 1775. Bushnell's chief object appears to have been the introduction of submarine warfare. His vessel, which was propelled by screws, somewhat resembling those now in use for steam-vessels, is described in the 'Transactions of the American Philosophical Society,' vol. iv., p. 303, whence the account was copied into 'Nicholson's Journal,' vol. iv., p. 229. The subsequent projects of Fulton for the same purpose have been referred to elsewhere. [FULTON, ROBERT, in BIOG. DIV.] In the article 'Diving-Bell,' in the 'Encyclopædia Metropolitana,' written by Mr. Babbage, a detailed plan is laid down for the construction of a vessel for submarine navigation. Among the suggestions there made are those of using oxygen, condensed in store-vessels, to replenish the air, and of absorbing the carbonic acid produced by respiration, either by cream of lime, or by a strong solution of ammonia.

DIVINING ROD, a forked branch, usually of hazel, by which it has been pretended that minerals and water may be discovered in the earth. The rod, if slowly carried along in suspension, dips and points downward, it is affirmed, when brought over the spot where the concealed mine or spring is situated. Other mysterious powers—such as those of discovering the lost boundaries of lands, identifying murderers, discovering hidden treasure, and even of detecting the birth-place and parentage of foundlings—have also been attributed to the divining rod. The rod is sometimes called the Virgula Divina, or the Baculus Divinatorius, or the rod of Aaron, or the Caduceus (after the wand of Mercury). Many persons with some pretensions to science have been believers in the powers ascribed to the divining rod. George Agricola, the able and learned German metallurgist of the 16th century, and in later times John Sperlingius and Theodore Kirchmaierus, who have both written *Disputatiunculæ* on the rod, all say the devil is in it. In 1690 appeared an account of a mason in Dauphiné, "who, guided by a hazel rod, followed a murderer for forty-five hours over land, and thirty hours on the water." Richelet, in his Dictionary (art. 'Baguette Divinatoire'), confesses that after what he has seen he cannot entertain any doubt as to its possessing the wonderful qualities ascribed to it. The learned Morhoff, who was eminent for his scientific as well as literary knowledge, admits that it is not clear to him whether the effects be natural or the result of demoniac agency. M. Thouvenot published at Paris, in 1781, a 'Memoir on the relation of the phenomena of the Divining Rod to those of Electricity and Magnetism;' and Pryce, in his 'Mineralogia Cornubiensis' (fol. 1778), has collected accounts of numerous successful experiments which he says were performed by the instrument. Some remarks on the rod and on the attempts that have been made to explain its fancied operation, may be found in the Marquis le Gendre's 'Traité de l'Opinion;' and there is a discussion of the subject, which is well worth reading, both for the reflections and some curious facts which it contains, in Bayle's 'Dictionary,' in the notes to the article 'Abaris.'

The present century has not been without its contributions, favourable and unfavourable, to the pretensions of diviners. Dr. Hutton, in 1803, in his edition of 'Ozanam's Recreations,' ridiculed the whole subject of divination. Lady Noel, mother of Lord Byron, hearing of this work, wrote to inform Hutton that she herself possessed this disputed power; that she had been induced to try by observing the success of a peasant in Provence; that, in company with Mr. Dawson Turner, at Warlingham, she had made a trial; that the hazel twig *did* turn when she came over a hidden stream of water; and that, so far from using any muscular force to make the rod turn, "her thumbs and fingers became quite reddened and sore from the efforts she made to keep it from turning." Thus challenged, Hutton invited her to Woolwich, where, according to the accounts of others (but not, we believe, of the learned mathematician himself) a hidden spring of water was pointed out by the divining rod. Dr. Herbert Mayo, in a series of articles published in 'Blackwood's Magazine,' in 1847, on the Truths contained in Popular Superstitions, and afterwards collected into a volume, placed some credence in the divining rod. He states it as a popular belief in Cornwall, that about one person in forty possesses the faculty of discovering the locality of veins of copper and tin by means of the rod. They proceed thus: A hazel twig is cut just below where it forks; it is stripped of its leaves; and then each branch is cut to about a foot in length, leaving a stump three inches long. The hazel fork thus prepared is to be held by the branches, one in each hand, the stump or point projecting forwards; the arms of the dowser or diviner hang by his sides, but the elbows being bent at a right angle, the forearms are advanced horizontally. The hands are held eight or ten inches apart, the knuckles down, and the thumbs outwards; the ends of the branches appear between the roots of the thumbs and fore-fingers. The experimenter walks over the ground in the full expectation that, if he possess the mystic gift, as soon as he passes over a vein of metal, or an underground spring, the fork will begin to move spontaneously in his hand, rising or falling as the case may be. When at Nassau, about the time of the publication of his papers, Dr. Mayo made many experiments by the aid of a young man named Edward Seebold, and two of his brothers, together with two other persons; these persons walked many times to and fro, on a piece of ground known to contain water beneath, holding prepared twigs of hazel in their hands; the hazel twigs made many circular and vibratory movements, apparently involuntarily on the part of the experimenters; but Mayo failed to draw any very definite conclusions on the matter: and in a later edition of his work, in 1851, he stated that Seebold seemed to have lost the power altogether. Mr. Phippen, in a pamphlet published in 1853, contends for the practicability of discovering water, metals, and coal by the divining rod. It appears that, being on a visit to his brother, a surgeon at Wedmore, in Somersetshire, the two were induced to test the powers of two dowsers or professional diviners, named Mapstone and Adams. Mapstone thereupon discovered a hidden spring of water, at a place where a farmer named Edwards was very anxious to sink a well. Adams also had the reputation of having dowsed successfully for more than a hundred wells, discovering not only water but metal, the existence of which underground had not been previously known to him. When these statements were made public in two of the London newspapers, Mr. Marshall, one of the partners in the great flax factory at Leeds, wrote to ask Mr. Phippen whether the facts had been correctly reported, and whether Adams would try his reputed skill in Yorkshire? A meeting was arranged; and Mr. Phippen prints in his pamphlet Mr. Marshall's account of what took place. The dowser certainly did succeed in naming, with a great approach to correctness, the exact locality of many springs underneath the ground; he being previously blindfolded, and led about in various directions. The power, whatever it might be, was not confined to a mere *spot* of water, but extended, it is stated, to a *line* or hidden watercourse. Adams, it is asserted, found that copper and iron wire succeeded with him nearly as well as a hazel twig.

Scientific men, almost without exception, regard the asserted power as a fraud or a delusion. Devonshire and Cornwall people stoutly assert its reality. M. Chevreul, in an essay published in 1854, 'De la Baguette Divinatoire, du Pendule dit Explorateur, et des Tables Tournantes, au point de vue de l'Histoire, de la Critique, et de la Méthode Experimentale,' classes the divining rod with table-turning, as being the performances of persons who deceive themselves, but do not knowingly or wilfully deceive others. If we look at the old practice of divination by Bible and Key, we should probably see that all rest on the same basis. Supposing property to have been stolen, a key was placed in a Bible, at the 1st chapter of Ruth, or the 19th of Proverbs, or the 50th Psalm; the main body of the key was tied tightly in the book, and the projecting loop or handle was hung loosely on a finger; the experimenter repeated the names of suspected persons, together with portions of the said chapters; and when the real thief was named, the key was said to fall off the finger. In Eusabe de Salle's 'Peregrinations en Orient,' published in 1840, the author describes a scene which he witnessed at the house of the English Consul at Aleppo, between an English lady and a Syrian Christian: a dispute arose whether she had received some jewellery from an Aleppo jeweller; she tried the Bible and Key test, and found it tell against herself; whereupon she left the room directly, made a search, and found the jewels in a drawer.

The subject has lately been a good deal discussed. The prevailing opinion among those who would dispassionately apply scientific tests, appears to be that the whole is an example of the phenomenon of *expectant attention*, or the effect of dominant impression on the mind, acting *unconsciously* upon and through the nerves and muscles.

DIVINITY. [THEOLOGY.]

DIVISIBILITY, DIVISOR. Any number or fraction admits of division by any other, in the extended arithmetical sense which considers *parts* of a time as well as times. Thus 12 contains 8 a time and half a time, or 12 divided by 8 gives 1½. The adjective *divisible* is nevertheless applied, not to any number as compared with any other, but only as compared with such numbers as are contained a whole number of times in the first. Thus 12 is said to be divisible by 6, and is said to be not divisible by 8. Or, both in arithmetic and algebra, divisible means "divisible without introducing fractions into the result."

The number of divisors which any number admits of is found as follows. Ascertain every prime number which will divide the given number, and how many successive times it will do so. Add one to each of these numbers of times, and multiply the results together. Thus, the number 360 is made by multiplying together 2, 2, 2, 3, 3, 5; or is divisible by 2 three times (3 + 1 = 4), by 3 twice (2 + 1 = 3), and by 5 once (1 + 1 = 2). And 4 × 3 × 2 = 24, the number of divisors which 360 admits of. But among the 24 divisors are included 1 and 360.

DIVISIBILITY OF MATTER. Every substance with which we are acquainted admits of being divided into parts, and each of these may be repeatedly subdivided. Indeed no limit has been assigned to this process of continual subdivision, although it is probable from chemical reasoning, that the ultimate elements of matter are indivisible and unalterable, whence they are called *atoms*. [ATOMIC THEORY.] We know nothing of the absolute size of these atoms, except that they cannot exceed certain magnitudes which may be calculated, but of their extreme minuteness we can form no correct idea. The following example from Tomlinson's 'Introduction to the Study of Natural Philosophy' will show how vain figures sometimes are to give adequate ideas of truth. It can be proved by geometrical reasoning, invented by Sir Isaac Newton, that "a film of soapy water will, if carefully protected from all disturbance, hold together until it has been reduced by draining to the thickness of less than a 2,600,000th of an inch. Pure water will not hold together in this way, but the admixture of less than the hundredth of its bulk of soap will confer this property on the whole of the water. Now, in order to produce this effect, it is evident that there must be a portion of soap (at least *one* atom) in every cubic 2,600,000th of an inch of the solution. But the soap, when dry, occupies less than 100th of the bulk of the solution. Therefore a single atom of soap, in the solid state, cannot possibly occupy so much as the hundredth of a cubic 2,600,000th of an inch; that is, not so much as a 1,757 trillionth (1,757,000,000,000,000,000,000th) of a cubic inch." In the same work an example is given in which Dr. Thomson, the chemist, shows that an atom of lead cannot weigh more than $\frac{1}{510,000,000,000}$th of a grain, while the atom of sulphur by which the lead is made visible cannot weigh more than $\frac{1}{2,015,000,000,000}$th of a grain.

Writers on natural philosophy are accustomed to excite the astonishment of their readers by details respecting the divisibility of gold, the enduring scent of musk, the minuteness of the blood discs, the attenuated but complicated structure of the spider's thread, the thousands of infusoria which might swim side by side through the eye of a needle, &c., but such details as these are of very little use except to prove what we already abundantly know, that matter is divisible, and that the limit of that divisibility has not been defined, even supposing the philosopher to have powers adequate to the definition.

DIVISION, the process of ascertaining how many times and parts of times one number is contained in another. The usual arithmetical rule consists in a continual approximation to the result required. We write underneath,—1, the common process; 2, that of which it is an abbreviation; 3, a short summary of the *rationale*.

```
8)23475(2934⅜          8)23475(2000
  16                     16000  900
  --                     -----
   74                     7475   30
   72                     7200    4
   --                     ----
    27                     275
    24                     240
    --                     ---
     35                     35
     32                     32
     --                     --
      3                      3
```

The whole contains a number as often as all its parts put together contain that number: and 23 meaning 23,000, and 16 being the highest multiple of 8 below 23, then the 16,000, which is part of 23,000, contains 2000 eights, and it is left to be seen how often the remaining 7000, and the 475 (making 7475) contain 8. The 74 is 7400, and 9 times 8 being 72, the 7200 which is part of 7400, contains 900 eights, and it is left to be seen how often the remaining 200 with the 75 (making 275) contains 8. The 27 is 270, of which the part 240 contains 30 eights, and the remaining 30 together with the 5 (making 35) is left. Of this, 32 contains 4 eights, and the remaining 3 does not contain 8 so much as one time, but the eighth part of 3 units is three times the eighth part of a unit, or ⅜: whence the answer.

In finding how many times, or parts of times, one fraction is contained in another, the following principle is applied. If two numbers or fractions be multiplied by any number, the number of times, or parts of times, which the first contains the second, is not altered. Thus 7 contains 2 just as 14 contains 4, or as 21 contains 6, &c. If then we take two fractions, such as $\frac{3}{7}$ and $\frac{2}{11}$, it follows that $\frac{3}{7}$ contains $\frac{2}{11}$ just as 77 times $\frac{3}{7}$ contains 77 times $\frac{2}{11}$, or as 33 contains 14: that is, 2 times and $\frac{5}{14}$ of a time. This may easily be shown to give the common rule.

The division of one decimal fraction by another presents a difficulty, slight indeed, but quite sufficient to prevent most persons from becoming expert in the use of tables. The rules given are frequently incomplete, and always such as would render even a practised computer liable to mistake. The question is how to place the decimal point rightly in the result, and this may be best done as follows:—

1. Alter the dividend or divisor by annexing ciphers, until both have the same number of decimal places. This being done—

2. Annex as many ciphers to the dividend, or take away as many from the divisor (or partly one and partly the other) as there are to be decimal places in the result: then divide as in whole numbers, and mark off the given number of decimal places.

Example I.—Find out, to three decimal places, how often ·076 is contained in 32·1.

First step: ·076 and 32·100.
Second step: ·076 and 32·100000.
76)32100000(422368—rem. 32.
Answer. 422·368.

Example II.—Find out, to 7 decimal places, how often (what fraction of a time) 236·5 is contained in ·001.

First step: 236·500 and ·001.
Second step: 236·5 and ·00100000; namely, *two* ciphers struck off the divisor and *five* annexed to the dividend (making *seven*).

2365)100000(42—rem. 670.
Answer. ·0000042.

In making complicated divisions, it is much the shortest plan, and very much the safest, to begin by forming the first nine multiples of the divisor by continued addition (forming the tenth for proof).

DIVISION OF EMPLOYMENTS, in political economy, is an important agent in increasing the productiveness of labour. It is by labour alone that wealth is produced. It is a law of man's nature, that "by the sweat of his face he shall eat bread;" and in return for his labour he acquires various sources of enjoyment. The ingenuity with which he has been endowed, and the hard necessities of his condition, lead him to discover the most effective means of applying his labour to whatever objects he may be seeking to attain. He desires, first, to work no more than is necessary; and secondly, to obtain the largest return—the most abundant enjoyment, for his industry. He soon finds that his own unaided labour will scarcely provide for him the barest necessaries, and that ease or enjoyment is unattainable. Thus, instead of each man labouring separately and independently of all others, many men combine together for securing the various objects of life, by means of their joint labour; and this combination of labour leads to division of employments. Labour is naturally exerted in these two forms in the very earliest stages of society. The first pair whom God's ordinances and their own instinct united, must have combined for the support of themselves and their common family, and diversity of sex alone must have produced distinct employments. Among savages the man engages in the chace, for which he has a natural predilection, and for which his strength adapts him, while his mate rears their children and executes those functions which are suited to her sex, but which are as conducive to the comfort of both as if both performed them. In this manner a division of employments naturally arises, and each family affords an example of its origin and character.

This combination for a common object, succeeded by a division of employments, pervades every process of human industry, and increases in variety and complexity with the growth of civilisation. One of the earliest forms of industry is that of fishing, and none, perhaps, exemplifies more aptly the mode in which labour is necessarily applied to the purposes of life. A man desirous of building a fishing-boat may cut down a tree, without any assistance from others, and may even hew it into shape; but if it be larger than a mere canoe he cannot, by his own strength, remove it from the spot on which the tree had fallen, and launch it upon the sea. To effect this, others must combine their strength with his. To manage a boat the labour of more than one man is ordinarily required, and the larger the boat the greater must be the number who combine to navigate it. If they paddle or row it, their labour is simply combined for one purpose and in one manner, except that one, instead of rowing, may probably steer the boat. As the art of navigation improves and its objects become multiplied, in addition to a more extensive combination of men in pursuit of the same objects, a diversity of employments ensues. In a deep-sea fishery, some attend to the nets, others to the sails; and on their return to land, some arrange the nets to dry and repair them, while others are engaged in disposing of the fish.

From these illustrations it is evident that the cause of a division of employments is to be sought in the nature and circumstances of man. It is not the result of extraordinary foresight, but is suggested by the most common exigencies of life; its convenience is obvious, but the feeling which prompts men to adopt it is spontaneous and as it were intuitive. It is a social necessity, and the very foundation of any social system whatever, yet it is practised almost unconsciously by the greater part of mankind. Its existence, however, lies so open to observation that it is scarcely to be ranked as a discovery of political economy; but that science, having noted the facts of a combination of labour and a division of employments, explains their uses and results; and in pursuing these inquiries it develops some of the most important principles connected with the production and distribution of wealth. To these inquiries we must now devote our attention.

As labour is the lot of man, it is desirable that his labour should be as productive as possible, in order that the sum of his enjoyments should exceed that of his endurance. This result is attained by several men combining their labour for one object, and pursuing different employments for their reciprocal benefit, instead of each man labouring independently for himself and employing himself in the same manner as all other men. A division of employments, therefore, is not only a natural incident of labour, but is an important auxiliary of human enjoyment. The means by which it adds to the efficacy of labour are described by Adam Smith to be—1st, an "increase of dexterity in every particular workman;" 2ndly, "the saving of the time which is commonly lost in passing from one species of work to another;" and, 3rdly, "the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many:" to which may be added, 4thly, the separation which it causes between labour and the direction of labour; 5thly, the power which it gives of using machinery effectually, when invented; 6thly, the opportunities of exchange which it affords, and the means of availing ourselves of the enjoyments arising from the natural capabilities of the soil, climate, situation, or mineral productions of different parts of the world, and of the peculiar aptitude of their inhabitants for various kinds of industry.

1. The superior dexterity of workmen engaged exclusively in one occupation is universally known. "Use is second nature," and when a man has been long accustomed to a particular employment, not only has he acquired great dexterity, but his mind appears to be endowed with faculties specially adapted to his business. The jockey seems to have been born for the saddle; the sailor for the ship: both are active, intelligent, dexterous; but fancy their occupations exchanged or combined! the sailor in the saddle, the jockey at the helm; or both alternately riding the favourite horse at Newmarket and furling the top-gallants of a three-decker at Spithead! The constant exercise of the faculties in any art or business gives them an aptitude for it, which to others is a matter of astonishment. The eye and the hand perform their offices with such precision and rapidity, that their work seems spontaneous, as it were, and independent of the will of the workman. Without deliberation, almost without care, the business is done; and done better than others could do it with the greatest pains. All processes of art and manufacture, and the daily experience of all men, confirm this statement as an unquestionable fact.—(Babbage, 'Economy of Machinery and Manufactures.') The advantages of peculiar skill are that men can work better and faster, that the products of their labour are more valuable and more abundant, and that their contributions to the general stock of the world's enjoyments are multiplied. By following out these advantages through all their relations, they will be found to be the primary source of wealth; and, in a moral point of view, the main cause of social progress and of the development of the highest faculties of man.

2. "The saving of time which is commonly lost in passing from one species of work to another" enables a man who is constantly engaged in one process to perform more work than he would have been able to get through in the course of a day, if he had been required to change his employment. For this reason, as well as on account of his skill, a division of employments makes his labour more productive.

3. The invention of tools and machinery is the most effective auxiliary of labour, and it is necessarily promoted by a division of employments. Those who are constantly attending to one business or description of labour must become best acquainted with its requirements—their observation and experience are concentrated upon it—their interest urges them to facilitate their own exertions. How many inventions are due to workmen employed in manual labour the history of the steam-engine and of the cotton manufacture will furnish examples; but it is not in the case of workmen alone that division of employments facilitates invention. Their employers also have their whole minds bent upon improving their business; and amidst the multiplication of trades arise engineers and machinists, whose sole business it is to construct, improve, and invent machinery, aided by all the lights of theoretical science. And this leads us to the fourth advantage of a division of employments.

4. If all men were doing the same thing, and working for themselves unaided by others, their condition would never be improved; but by following particular occupations, those who exert most skill and industry produce more than they require for their own subsistence, and reserve a fund for the employment of others. [CAPITAL.] And thus there grows up from the midst of the people a class of employers who direct the labour of others. Until labour is so directed and maintained by the previous accumulation of capital, it is comparatively ineffectual; and while a division of employments is a powerful agent in producing capital, the latter, in its turn, facilitates a further subdivision. Without it, indeed, a system of division can only be carried out imperfectly and to a very small extent. The growth of capital also gives to many men the glorious privilege of leisure, exempts them from the necessity of labour, and leaves them free to study, to reflect, to observe, to reason and investigate. From this class arise men of science and of letters—philosophers, statesmen, historians, poets. And even with these the apportionment of a peculiar province gives power to their minds, and expands their knowledge. Their natural talents are developed, and their aptitude for particular pursuits becomes as conspicuous in intellectual industry as that of other men in manual operations.

5. Adam Smith speaks of the importance of a division of employments as leading to the invention of machinery, but passes over its utility in using machinery effectually, when invented. Every part of a large machine requires workmen whose sole business it is to work in unison with its peculiar movement. So distinct are these various processes—so diverse their character—that in all large manufactures there is an extensive vocabulary of names by which operatives working in the very same factory are distinguished. Without such a subdivision of peculiar employments the most ingenious machinery would be useless: and thus while machinery multiplies distinct operations of labour, these are, in their turn, essential to its efficacy.

6. Adam Smith assigns the origin of a division of employments to the "trucking disposition" of mankind—to their "propensity to truck, barter, and exchange one thing for another" (b. i. c. ii.). This love of barter however is only a secondary cause: men have no natural taste for it; but use it as a means of obtaining the various objects which they desire. If they could obtain them without the trouble of barter, they would unquestionably not follow barter as an amusement, any more than they would work if they could get what they wanted without labour. So far, then, from the trucking disposition of men being the cause of a division of employments, it would appear that a division of employments is rather the proximate cause of commerce. For if all men worked in the same manner and produced the same things, there would be nothing to exchange: but as soon as men learn to devote themselves to the production of one commodity, the whole of which they cannot consume, they must exchange the produce of their labour with others, who have been producing objects which they desire to possess. This is an intelligible origin of barter and commerce—consistent with the natural propensities of mankind, and not requiring for its support the strained hypothesis that men have an innate disposition to truck. But a division of employments, like barter, is itself but a secondary cause; and both alike must ultimately be referred to the one original cause of all forms of industry—the desire of mankind to possess various enjoyments which are only to be gained by labour.

This would appear to be the natural course of social progress. First, a man applies himself to a particular business because he has facilities for following it. One man lives by the sea and is a fisherman; another lives near the forest and hunts game. Each could obtain more of this particular food than he requires for his own use, and may desire some little variety. Under these circumstances it is very natural that they should effect exchanges with each other—not for the mere love of barter—but for the love of food. But such an exchange could not be made between two men who both lived by fishing—nor between two others who both lived by hunting; for under such circumstances neither party would have anything to offer but that of which the other already had enough. It is perfectly true that without barter no extensive division of employments can exist; but it is clear that barter is the immediate effect rather than the cause of such division. Of the influence of commerce upon the division of employments we shall have to speak presently; but in this place it is sufficient to show that the production of different commodities beyond the immediate wants of those who produce them enables men to barter, by giving them something to offer in exchange; and that afterwards the advantages derived from barter are an encouragement to further production of the same kind.

When this state of things has been once established, men avail themselves of all the natural advantages of their several positions, and apply themselves to the production of those commodities for which they have peculiar facilities. In one country minerals can be drawn from the bowels of the earth in unlimited abundance; in another the fruits of the earth teem upon its surface—fostered by a genial climate and a fertile soil. The inhabitants of these countries naturally seek to develope the resources of the earth which are within their reach. They labour effectively and produce abundance of their particular commodities, which they give in exchange for other things which they cannot produce themselves, but which they desire to enjoy: and thus a division of employments, by the aid of an extended commerce, distributes over the whole world the advantages of soil, climate, situation, and mineral productions, obtained by the experience and skill of men who have adapted their talents to the circumstances of each country.

Having thus hastily enumerated the several ways in which a division of employments adds to the efficacy of human labour, and increases the enjoyments of men, let us inquire in what manner it is restrained and limited. It may be collected from several of the preceding remarks, that the power of distributing men into particular employments must be limited by the extent of the market in which the produce of their labour may be exchanged. When there are no means of exchanging, men must provide everything for themselves that they require; and there is no further division of employments than that which necessarily takes place in families, and in the most simple forms of industry. So in every degree in which the situation and circumstances of men give facilities of exchange, do particular employments become assigned to individuals. A village draper sells all kinds of drapery, together with hats, shoes, coats, smock-frocks; nay, in some villages there is but one shop, in which nearly every kind of trade is carried on. In a populous city, on the other hand, trades are almost indefinitely subdivided. And why is this? Solely because of the extent of the market. In the one case, if a man sold nothing but hats, he could not gain a livelihood, and therefore he sells coats, smock-frocks, shoes, and all kinds of drapery—everything, in fact, which the people round about him are likely to buy. In the other case, there is so large a demand for hats, that a man can gain a better livelihood by the exclusive sale of them, than by a heterogeneous trade like that of the village shopkeeper.

But while, by means of exchange, employments are thus subdivided, the labour of many men is most efficiently combined in producing particular results. The combinations of industry for one object are often truly wonderful, while the employments of those who are really co-operating with one another are so distinct that they are wholly unconscious of any combination at all; nor is their combination at once perceptible to others. If you ask a man "who made his coat?"—he will naturally answer "his tailor." But ask him to enumerate the persons who had contributed to its production, and he will pause long before he attempts any answer, however incomplete. He will be reminded of the grazier, the shepherd, the wool-salesman, the various workmen in the cloth factory—the button-makers, the manufacturers of silk, and thread, and needles: but still the catalogue will be imperfect. In producing the raw materials, and in conveying, selling, and manufacturing them, the diversity of occupations is extraordinarily great. Each man attends to his own business, and scarcely thinks of its relations to the business of other people; and yet all are co-operating in the most effectual manner, for the most perfect and economical manufacture of this finished work of varied art.

The general operation of the principles of a combination of labour and division of employments has now been sufficiently explained so far as it relates to the efficiency of human industry. Of its effects upon the distribution of wealth (another important branch of political economy) no more need be said, than that by multiplying the modes in which industry is made productive, it is the main cause of the various grades of society which exist in all civilised countries. The different employments of men determine their social position as labourers or employers of labour; and the wealth arising from the effective employment of labour is distributed, through the several classes, as rent, profits, and wages.

It has been urged as an objection to an extended division of employments, that it unfits men for any change of business which altered circumstances may require; and that, on that account, great misery is caused when the demand for any particular kind of labour is reduced. Of this position the hand-loom weavers of England and Scotland are a familiar example, who are said to have been thrown out of employment by the extension of machinery. That they have been reduced to great distress is certain; but in their employment there was nothing to unfit them from engaging in power-loom weaving. On the contrary, the transition from one employment to the other would have been perfectly natural; but they preferred their independent life to the discipline of a factory, and for that and other reasons persisted in continuing in their old trade. In the mean time thousands of agricultural labourers and their families, whose occupations had been totally dissimilar, flocked into the manufacturing districts, and readily learned their new business. This example, therefore, instead of sustaining the objection, proves that a division of employments does not disable men, so much as might be expected, from transferring their labour to other departments of industry whenever a sufficient inducement attracts them. But any interruption or change in the ordinary course of industry is necessarily productive of temporary suffering to the working classes, from whatever cause it may arise; and an alteration in the forms of applying labour is but one out of many such causes. Yet much as this evil must be deplored, it is a satisfaction to know that it is only occasional, temporary, and partial in its operation, while the permanent welfare of mankind is promoted by all those means which render industry most productive and multiply the sources of human enjoyment.

Another objection to a minute subdivision of employments is, that it reduces vast masses of men to the condition of organised machines, uses them like tools, and uses them as such merely because machines have not yet been invented to do their work. From these facts, which are, to a certain extent, undeniable, it is inferred that the moral and intellectual character of men is degraded. This inference, however, is not supported by experience. Agricultural employments are less subdivided than trades and manufactures; but no one will contend that the farm labourer is ordinarily more intelligent than the operative, or that his morals are decidedly superior. In comparing their relative condition, we shall be led into error if we confine our attention to the influence of a division of employments. In the lower departments of labour the work is rarely of a kind to enlarge the understanding, whether it consist of a combination of several occupations or of one only; and in either case the greater part of a man's time is engaged in his daily work. It is therefore to the circumstances by which he is surrounded, rather than to the nature of his work itself, that we must generally refer his condition. In thinly peopled countries there can be comparatively little division of employments, and in populous cities the principle of division, for reasons already explained, is carried very far. In the one case the intercourse of persons with each other is very confined, and is enlivened with scarcely any variety; in the other case persons are crowded together, and brought into continual intercourse. These opposite circumstances produce different results for good and for evil. The intelligence of mankind is unquestionably increased by extended intercourse with one another: their morals, at the same time, are more liable to corruption. In large cities they are exposed to more temptations—they are under less restraint; and above all, they have, almost universally, higher wages, which enable them to indulge their propensities more freely. Much of the intellectual disparity of rural and town populations might be removed by an efficient system of education, by which men would be better qualified to observe and reflect upon the objects by which they may be surrounded; and great would be the moral influence of education in rendering high wages innocuous, by offering liberal sources of recreation to the operative, more attractive than the temptations of vice.

But to all objections it may be answered, that a division of employments is an imperative law of civilisation. Where land is abundant, families naturally scatter themselves over it, and provide for themselves nearly all that they want. More than they want they do not produce, as there is no market; and the growth of capital, under such circumstances, is impossible. But where land becomes scarce and dear, men are forced into other employments distinct from agriculture; capital grows, wages are offered as an inducement to work, and the more wealthy and populous a country becomes, the more extensive must be the distribution of separate employments. To object to a division of employments, therefore, is no less than to object to civilisation altogether; for the two conditions are inseparable. It is deeply to be lamented that many evils have hitherto clung to the progress of civilisation, which are not its necessary accompaniments. Many of them may be referred to the slow growth of political science, and might be corrected by the application of sound principles of government; many may be attributed to the neglect of the religious and moral culture of an *increasing* population: but short indeed must be the sight of any man who would seek to correct them by applying to a civilised state the rude expedients of barbarism.

DIVORCE (*divŏrtium, a divertendo*, from diverting or separating) the legal separation of husband and wife. The question of the legal dissolution of marriage has, after several commissions and much discussion, been settled by the British legislature by the 20 & 21 Vict. c. 85. It was enacted, that a court should be constituted in the name of the sovereign, to be called "The Court for Divorce and Matrimonial

Causes," such court to possess all the jurisdiction which the ecclesiastical courts have exercised in respect of divorces *à mensâ et thoro*, suits of nullity of marriage, restitution of conjugal rights, or jactitation of marriage. Thus the old form of proceeding for a separation from bed and board (*à mensâ et thoro*) is abolished, and for it is substituted the procedure for a "judicial separation," which is, in effect, a severance of the marriage tie, save that it does not enable either of the parties to marry again; but it places the woman in the same position as a *feme sole*, enabling her to hold and deal with property wholly free from the control of her husband; and in the case of the man, relieves him from all obligation to support his wife, and frees him from the possibility of having a spurious issue palmed upon him. But this court is armed with further power: it can absolutely separate man and wife so as to enable both of them to marry again. It can make provision for the injured wife according to the means of the guilty husband, by the name of "alimony." It can allow damages, if asked for, against the adulterer, and order him to pay the costs of the proceedings. It can, moreover, by the amending Act (22 & 23 Vict. c. 61), direct the custody of the children, and make such provision for the children of the marriage or their respective parents, out of any property which is the subject of ante- or post-nuptial settlement, as to the court shall seem fit. Thus the indissolubility of marriage is no longer maintained by the law of England. It is no longer necessary to resort to the legislature for a special Act of Parliament, preceded by a suit in the Ecclesiastical Court for a separation *à mensâ et thoro*, and an action against the adulterer for damages at common law, to obtain a divorce; but the wronged party may now at once, at no great cost, and with little delay, obtain relief from one of the most grievous evils of social life. It must, however, be said, that the wife cannot obtain a dissolution of her marriage (so as to enable her to marry again), unless the adultery of her husband is coupled with desertion of her for two years and upwards without reasonable cause, or with gross cruelty, or with bigamy, and some revolting offences; whereas the husband may obtain a divorce upon proof of his wife's adultery alone. In no case, however, will a divorce be granted if there has been collusion or connivance between the husband and wife with a view to obtaining a decree of the court. Nullity of marriage, although dealt with by the same tribunal as divorce, is distinct in its nature: it does not involve the dissolution of a marriage; but the object sought in such a proceeding is, an authoritative declaration that there never was any legal marriage between the parties, that it is null and void *ab initio*. The grounds of such a decree may be physical or mental incapacity to engage in such a contract, a previous marriage, consanguinity or affinity (in which is included marriage with a deceased wife's sister or husband's brother); also force, or fraud, or duresse to procure the marriage; also *error de personâ*, as where a person intending to marry one *individual* is actually married to another. Proceedings for restitution of conjugal rights may assume the shape of a suit for judicial separation, or even for a dissolution of marriage. The prayer for a direction to return to cohabitation may be met by the answer, that to do so would be dangerous to health or safety, or that adultery has been committed; either of which, if established, would justify the withdrawal from cohabitation: and in the one case, a decree of judicial separation would follow; and in the other, that of a dissolution of marriage.

Such is a brief summary of the change made in the matrimonial law of England. Scotland still retains its own peculiar laws on this subject; and Ireland is not as yet affected by the alteration of the law of England. And since so great an innovation has been introduced, it may not be out of place to notice the light in which the contract of marriage has been viewed by ourselves and some other nations.

From the curious document preserved by Selden ('Uxor Ebraica,' c. xxx., vol. iii., 845, folio ed. of his works), whereby John de Cameys, in the reign of Edward I., transferred his wife and her property to William Paynel; and also, from the reference to the laws of Howel the Good, at the end of this article, it would seem that, in the early periods of English law, a divorce might be had by mutual consent; but all trace of such a custom is lost.

By the common law of England marriage was a civil contract, and the ordinary courts of justice asserted their jurisdiction over this as well as every other description of contract. At length, the rite of marriage having been elevated to the dignity of a sacrament by Pope Innocent III., 1215, the ecclesiastical courts asserted the sole jurisdiction over it. And notwithstanding it was divested of that high character at the Reformation, it still remained in the eye of the law a religious contract, necessary to be celebrated by some formal rites wherein the priest was to officiate; and generally, except under special exemption, necessarily within the walls of a sacred edifice; wherefore it was that the ecclesiastical courts treated the matrimonial tie with such reverence, and the law of the land deemed the contract indissoluble, thus rendering it necessary to resort to the legislature for a special act of parliament to set aside a marriage. It was not, however, without doubt and much discussion that the opinion that marriage was indissoluble was arrived at by the early reformers. In the reign of Edward VI., Parr, the Marquis of Northampton, obtained a divorce in the Ecclesiastical Court by reason of the adultery of his wife, a commission (over which Cranmer presided) was appointed to inquire whether he could marry again; but before a decision was given he did marry again. The commissioners afterwards answered, "That the bond of wedlock being broken by the mere act of infidelity, the second marriage was lawful." The Marquis, however, applied for and obtained an act of parliament confirming the marriage. But the act was repealed in the following reign (that of Mary). In the following reign of Elizabeth was renewed the endeavour (which had failed in the reign of Edward VI.) to frame such laws ecclesiastical as should be thought convenient, under the name of "Reformatio legum;" one of those laws, "de adulteriis et divortiis," allowed a marriage to be dissolved by the ecclesiastical judge for adultery, desertion, long absence, mortal enmities (shown in overt acts, such as threatening life), lasting cruelty of a husband towards his wife. In all these cases the innocent party, whether wife or husband, might marry again. Severe penalties were denounced against adulterers, and the *divorce à mensâ et thoro* was abolished, but this code of laws never received royal confirmation, and therefore did not become law, and the question whether a complete divorce could be decreed by any strictly legal tribunal remained undetermined until the year 1571, when it was decided in the "Star Chamber" (a tribunal, although most arbitrary and despotic, still of binding authority), in a case known as "Foljambe's case," that the second marriage of a husband divorced from his first wife by reason of her incontinency, was still a void marriage, because the first divorce was only *à mensâ et thoro*, and not *à vinculo matrimonii*, (that is, the bond of marriage), reverting to the old ecclesiastical theory,—that a marriage could not be dissolved by the spiritual court, which alone had cognisance of the matter. In 1603, under the auspices of James I., the canons which still regulate and bind the clergy were enunciated. In one of them (the 107th) it is declared that parties separated *à mensâ et thoro* shall not during each other's life contract matrimony with another person, consequently any clergyman of the established church would, apart from any other legal consequences, have been amenable to ecclesiastical censure and punishment had he knowingly performed the ceremony of marriage where either of the parties to such marriage had been separated by a mere divorce *à mensâ et thoro*.

To satisfy the scruples of the clergy, a proviso has been inserted in the act (20 & 21 Vict., c. 85, s. 57) that "no clergyman in holy orders of the United Church of England and Ireland shall be compelled to solemnise the marriage of any person whose former marriage may have been dissolved on the ground of his or her adultery, or shall be liable to any suit, &c., for refusing to solemnise the marriage of any such person." The next section provides that in the case of any minister's refusal any other minister may perform the service.

In the reign of Charles II., a loose and profligate period of our history, the aid of the legislature was sought to enable Lord Roos, who had obtained a divorce *à mensâ et thoro*, to marry again. Although the bill was strongly opposed, it passed, but it is said by the historians (Burnett among others), that there was a strong political bias in its favour with reference to the king's being divorced and re-married, with a view to bar the Duke of York's succession to the crown. Here, however, the legislature did not dissolve the marriage, but about thirty years afterwards an actual dissolution of the nuptial tie was enacted in the case of the Countess of Macclesfield, the reputed, if not the actual, mother of Savage the poet. Three years after this followed the Duke of Norfolk's case; and immediately afterwards that of a Mr. Rox. Thus the privilege was no longer confined to those in high places; the right to obtain an act "to dissolve a marriage and to enable the petitioner to marry again" (that is if the husband), became established, provided a person were rich enough to bear the costs of the application.

The causes admitted by various codes of laws as grounds for the suspension or dissolution of the contract of marriage, as well as the description of the tribunal which had, or in some degree has, jurisdiction over the proceedings, are various, and indicative of the degree of civilisation of the nations among whom they prevailed.

According to the law of Moses (Deut. xxiv. 1), "When a man hath taken a wife, and married her, and it come to pass that she find no favour in his eyes, because he hath found some uncleanness in her: then let him write her a bill of divorcement, and give it in her hand, and send her out of his house." After ninety days, the wife might marry again; but after she had contracted a second marriage, though she should be again divorced, her former husband might not take her to be his wife. The form of a Jewish bill of divorcement is given by Selden, 'Uxor Ebraica,' lib. iii., ch. 24; and see Levi's 'Ceremonies of the Jews,' p. 146.

As the customs of Oriental nations do not change, we may conclude that the usages in the matter of divorce now existing in Arabia are the same, or nearly so, as when Mohammed endeavoured to reform them among the tribes for which he legislated. An Arab may divorce his wife on the slightest occasion: he has only to say to her, "Thou art divorced," and she becomes so. So easy and so common is this practice, that Burckhardt assures us that he has seen Arabs not more than 45 years of age who were known to have had 50 wives; yet the Arabs have rarely more than one wife at a time.

By the Mohammedan law, a man may divorce his wife orally and without any ceremony; when this is done, he pays her a portion, generally one-third of her dowry. He may divorce her twice, and take her again without her consent; but if he divorce her a third time, or put her away by a triple divorce conveyed in the same sentence, he cannot receive her again until she has been married and divorced by another husband, who must have consummated his marriage with her.

For fuller information as to the Jewish and Mohammedan law of divorce, see Sale's 'Koran;' Lane's 'Modern Egyptians;' Hamilton's 'Hedaya,' and the 'Mishcat ul-Masâbih;' Selden's 'Uxor Ebraica;' and see the case of Lindo *v.* Belisario, 1 Hagg. 'Consy. Rep.' 216, before Lord Stowell.

Among the Hindoos, and also among the Chinese, a husband may divorce his wife upon the slightest grounds, or even without assigning any reason. Some of the rules mentioned by the Abbé Dubois, as laid down in the 'Padma Purana,' one of the books of highest authority among the Hindoos, show their manner of thinking concerning the conduct of their wives. The reasons for which, according to the Brahmanic law, a man may divorce his wife, may be seen in Colebrooke's 'Digest of Hindoo Law,' vol. ii., p. 414, &c., 8vo. edit.; and Kalthoff, 'Jus Matrimonii veterum Indorum' (Bonn, 1829, 8) p. 76, &c.

The laws in the several Grecian states regarding divorce were different, and in some of them men were allowed to put away their wives on slight occasions. The Cretans permitted it to any man who was afraid of having too great a number of children. The Athenians allowed it upon small grounds, but not without giving a bill containing the reasons for the divorce, to be approved (if the party divorced made an appeal) by the chief archon. The Spartans seldom divorced their wives; indeed the ephori fined Lysander for repudiating his wife. Ariston (Herod. vi. 63) put away his second wife, but it seems to have been done rather to have a son, for his wife was barren, than according to the custom of the country. Anaxandrides (Herod. v. 39) was strongly urged by the ephori to divorce his barren wife, and on his not consenting, the matter was compounded by his taking another wife: thus he had two at once, which Herodotus observes was contrary to Spartan usage.

By the laws of the early Romans, the husband alone was permitted to dissolve the marriage, but not without just cause, and a groundless divorce was punished by the forfeiture of the husband's effects, one-half of which went to the wife. Adultery, drunkenness, or counterfeiting the husband's keys, were considered good causes of divorce. (Dion. 'Hal.,' ii. 25; 'Gellius,' iv. 3; Plutarch, 'Vit. Rom. et Num.') For about 500 years after the foundation of the city there was no instance of this right being exercised by the husband; but afterwards divorces became very frequent, not only for sufficient reasons, but on frivolous pretexts, and the same liberty was enjoyed by the women as by the men.

The maxim of the civil law was, that matrimony ought to be free, and either party might renounce the marriage union at pleasure. It was termed *divortium sine causâ*, or *sine ullâ querelâ*, that is, divorce without cause, or without question; and the principle, *bonâ gratiâ matrimonium dissolvitur*, matrimony is dissolved at pleasure, is solemnly laid down in the pandects. The abuse of divorce prevailed in the most polished ages of the Roman republic, though as has been said, it was unknown in its early history. Voluntary divorces were abolished by one of the *novels* of Justinian, but they were afterwards revived by another *novel* of the Emperor Justin. In the *novel* restoring the unlimited freedom of divorce the reasons for it are assigned; and while it was admitted that nothing ought to be held so sacred in civil society as marriage, it was declared that the hatred, misery, and crimes, which often flowed from indissoluble connections, required as a necessary remedy the restoration of the old law by which marriage was dissolved by mutual will and consent. This practice of divorce is understood to have continued in the Byzantine or eastern empire till the 9th or 10th century, and until it was finally subdued by the influence of Christianity.

On a divorce for infidelity, the wife forfeited her dowry; but if the divorce was not made for any fault of hers, her whole dowry was restored, sometimes all at once, but usually by three different payments. In some instances, however, where there was no infidelity on the part of the wife, only part was restored. On the Roman divorce and dowry, see 'Dig.,' xxiv., tit. 2, 3.

Among the ancient Britons, it may be collected from the laws of Howel the Good, that the husband and wife might agree to dissolve the marriage at any time, in which case, if the separation took place during the first seven years of the marriage, a certain specified distribution of the property was made, but after that period the division was equal. No limit was set to the husband's discretion in divorcing his wife, but the wife could only divorce her husband in case he should be leprous, have bad breath, or be impotent, in which cases she might leave him and obtain all her property. The parties were at liberty to contract a fresh marriage; but if a man repented of having divorced his wife, although she had married another man, yet if he could overtake her before the consummation of the marriage, or, as the law expresses it, "with one foot in the bed of her second husband, and the other outside," he might have his wife again.

Adultery was punishable by fine.

The laws of Scotland relating to divorce differ widely from those existing in England: there, a divorce *à vinculo matrimonii* is a civil remedy, and may be obtained for adultery (but the guilty parties cannot intermarry), or for wilful desertion by either party, persisted in for four years, though to this a good ground of separation is a defence. But recrimination is no bar to a divorce as it is in England.

In the Dutch law there are but two causes of divorce *à vinculo matrimonii*,—namely, adultery and desertion.

In Spain the same causes affect the validity of a marriage as in England, and the contract is indissoluble by the civil courts, matrimonial causes being exclusively of ecclesiastical cognisance. ('Instit. Laws of Spain.')

The law of France, before the Revolution of 1792, following the judgment of the Roman Catholic Church, held marriage to be indissoluble; but the legislators of the early revolutionary period permitted divorce at the pleasure of the parties, even where incompatibility of temper alone was alleged. This, however, led to a great abuse of the privilege. The Code Napoleon accordingly restricted the liberty, but still allowed either party to demand a divorce on the ground of adultery committed by the other; for outrageous conduct, or ill usage; on account of condemnation to an infamous punishment; or by mutual consent, provided it was formally declared by both that their life was insupportable. By the same code, a woman could not contract a new marriage until the expiration of ten months from the dissolution of the preceding. Adultery is now treated in France as a criminal offence.

It must be borne in mind, however, that the Roman Church, for the purpose of increasing its revenue, has at all times claimed the right to dissolve marriage by dispensation; and therefore this power of divorce still exists in France, and all Roman Catholic countries, independent of the law of the land.

In the United States, marriage, though it may be celebrated before clergymen as well as civil magistrates, is considered as a civil contract. The causes of divorce, and the power of obtaining it, are by no means the same in the several states. Nullity of marriage is decreed on the ground of a former marriage, physical incapacity, consanguinity, or fraudulent contract, by the Connecticut law; and by the New York code, idiotcy and insanity, and either party being under the age of consent. Adultery is a cause of divorce *à vinculo matrimonii*; and the laws of some of the states prohibit the guilty party from marrying again. If the husband or wife is absent seven years, or, by the laws of some states, three years, and not heard from, the other is at liberty to marry again; and in some states, if the husband desert the wife, and make no provision for her support during three years, being able to make such provision, the wife can obtain a divorce. Extreme cruelty in either party is also generally a cause of divorce *à vinculo matrimonii*. In many of the states, applications to the legislature for divorce, in cases not provided for by the statutes, are very frequent. In New York and New Jersey, divorce is a subject of Chancery jurisdiction, from which, as in other cases, questions of law may be referred to a jury for trial. In New Hampshire, joining the religious society of Shakers, who hold cohabitation unlawful, and continuing in that society for three years, is sufficient cause for a divorce. But in most of the states, the courts of law have cognisance of divorce. The laws prescribe the provision to be made for the wife in case of divorce, confiding to the courts, however, some degree of discretion in fixing the amount of alimony.

It will thus be seen that the law regulating divorce is by no means uniform throughout the United States, and ofttimes embarrassing questions arise when a marriage is had in one State, and a divorce in another. See Bishop on *Marriage and Divorce*; and Story's *Conflict of Laws*; and Kent's *Comm.*; *Ency. Americ.* Upon the general advantages of indissolubility, as opposed to an unlimited right of divorce, see Hume's *Essay on Polygamy and Divorce*; Paley's *Moral Philosophy*; and the judgment of Lord Stowell in Evans *v.* Evans, 1 Hagg. *Consy. Repts.*, 48; Milton's treatise on divorce; and Gibbon, *Decl. and Fall*, c. 44.

DIWÂN. [DIVAN.]

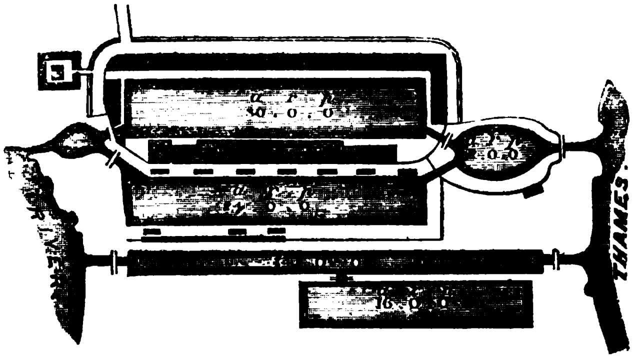
DO, in music, the name given by the Italians and the English to the first of the syllables used in solmization, or solfaing, and answering to the *ut* of the French.

DOCK. An enclosure from a water surface resorted to by shipping, in which the latter can lie in safety from the various accidents attached to rivers or arms of the sea in their natural state, or in which the operations of loading and unloading can be performed without being interfered with by the variations of the water level. Of late years, however, the generic term "dock" seems to have been more particularly applied to the enclosures which are surrounded by bonding warehouses, whilst the simpler enclosures of this description which are not so surrounded are distinguished as "basins." The enclosures specially appropriated to the repairs of ships, "in the dry," are known by the name of "dry docks," or "graving docks."

The construction of docks, with the express intention of maintaining the water in them at such a level as to keep the ships constantly afloat, is of comparatively very recent date: for the Mediterranean, upon which nearly all the commerce of the ancient world was carried on, presents very little difference of level at the various times of the tides; and indeed the class of vessels employed in trade by the ancients was not of such a size or so constructed as to render it indispensable that they should always be kept afloat. About the beginning of the last century the size of merchant vessels began to increase; and it was then found that, especially in such ports as Liverpool, they were exposed to receive serious injury from the periodical "beaching" they were compelled to undergo, in consequence of the fall of the tides and the shallowness of the water near the shore.

Under such circumstances, therefore, the port authorities of the districts alluded to directed their attention to the creation of closed basins wherein the vessels might ride in safety; and it was at Liverpool that the first recorded great works of this description were executed, by the formation in the year 1710 of the dock at present known by the name of the Old Dock, and of the St. George's Dock, in 1762. The system thus inaugurated was found to be so advantageous that it was followed rapidly by other commercial towns, but it was not until the commencement of the present century that the metropolis of England followed the example; when, however, it did so, the great improvement of surrounding the basins with bonded warehouses was likewise introduced, and the complete modern system of docks was, for perhaps the first time, applied in the West India and the London Docks, respectively opened in 1802 and 1805. Nearly all the best modern docks have been constructed upon this system, and it has even been copied in foreign countries; for the Entrepôt Dock of the port of Hâvre, and the new docks of Marseille, are built with all the accessories to be found in the London establishments of this nature.

Leaving out of account for the present the docks exclusively devoted to one particular class of traffic, such as the coal docks of the North of England and of Wales, it may suffice to say that in tidal rivers, where the variations in the height of the water are great, it is desirable to form, immediately behind the exit or the entrance lock gates a half-tide basin wherein vessels of small draught may lie until the level of the water on the outside shall rise to such a height as to allow of their movements being carried on. The entrance to the dock basin itself should be placed at the upper end of the half-tide basin; and it is desirable that all the locks should have double gates, pointing respectively up and down stream. If, in consequence of the Customs regulations of the country, it should be necessary to form import and export docks, it would also be desirable to place the gates leading to and from them at the upper end of the half-tide basin, which in such cases must be made wide enough to allow the various movements of the vessels to take place without their being crowded; and, as a general rule, it may be said that the import dock should be situated on the left and the export dock on the right-hand side. The basins, in such cases as supposed, should communicate at their upper ends only; and the vessels should, after being unloaded, be warped through the lock or communication channel to the berth where it is to take in its cargo. Notwithstanding some practical defects in its details, the plan of the West India Docks, as originally designed by the late Mr. J. Rennie, was one of the most logical of any which has been hitherto suggested—that is to say, for ports where the Customs regulations are rather vexatious—and as such it is here introduced.



WEST INDIA DOCKS.

If these leading principles are carefully borne in mind, the details of execution of a dock may be modified to suit local circumstances, and in such cases as Bristol, Ipswich, &c., the formation of these marvellous facilities to commerce may be made conducive to the improvement of the navigation itself. In both the cases mentioned, old branches of the rivers were operated upon, in which the stream naturally followed very tortuous courses, and thus lost a portion of its power of transmitting the tidal wave to the interior; by cutting new and straight courses for the streams, and by converting the old channels into closed basins, not only was a considerable area of water surface made available for the purposes of trade, but the "regimes" of the rivers were rendered more stable and better fitted for traffic purposes. There is a further advantage attending such a conversion of the bends of rivers, namely, that generally speaking in such cases it is possible to make locks at both ends of the chord of the arc formed respectively by the new cut and by the enclosed water surface; but it is impossible to lay down any invariable rule in a matter which must admit of so many modifications in consequence of the physical and commercial conditions of the places under consideration.

The only invariable laws with respect to the formation of docks appear to be that, 1st, the area of water surface should be as small as possible in proportion to the development of the quay walls. 2nd, If a simple parallelogram be the form adopted the width may be calculated upon the principle that, *at the maximum*, three tiers of ships might lie alongside the quays on either side, and that there should be a sufficient space between the outer tiers to allow a vessel to swing round: the widths and lengths which form the basis of this calculation would of course depend on the class of vessels frequenting the harbour or river. 3rd, The whole of the basins and of the warehouses, courts, yards, quays, &c., should be securely enclosed, both for the purposes of the fiscal relations of the port and for the protection of the merchandise there unloaded: it was, indeed, principally on account of the robberies committed on the Thames and in the warehouses alongside the river that the docks of London were originally proposed. 4th, The depth of water in the floating basin must be such as to allow the vessels to float at all times of the tides; in many cases, as at Hâvre, for instance, the necessity for observing this precaution has rendered it indispensable to sink the bottom of the basins considerably below the level of the bed of the sea in the outer harbour. It is desirable also, in order to avoid inconvenience from rapid silting up of the basins, to allow originally a depth rather in excess of that which is theoretically required. 5th, If the docks should be constructed in such positions as to allow vessels to sail directly into them, they must have an outer harbour sufficiently long and secure in which the vessels may loose their "way," or the impetus of advance, before they approach the half-tide basin or the inner lock.

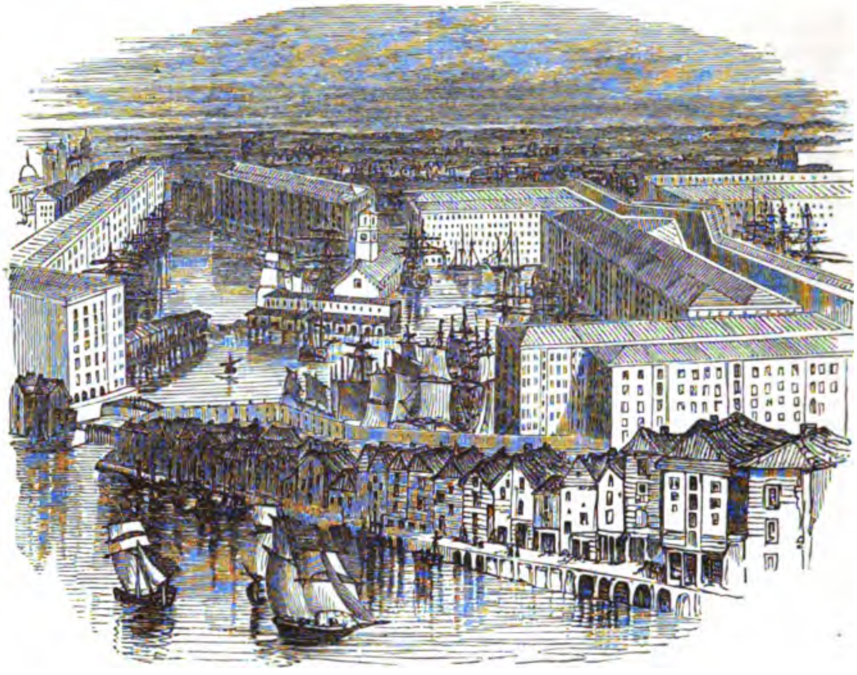
The details of the quays, and of the sheds and warehouses, must depend upon the character of the trade at the particular place under consideration, and upon the customs regulations of the country. As a general rule it would, however, appear to be preferable to make, on the immediate edge of the quay, a paved road or gangway, of about 20 feet in width, without any roofing, and to place on this gangway the cranes for unloading or loading. It is found, indeed, that goods arriving from great distances, whether by land or by sea, require that their cases or envelopes should be examined and repaired before the goods are transmitted or shipped. This operation is sometimes known by the phrase *coopering*, and the open space above recommended, affords facilities for its execution, as well as for the operation known under the name of *sampling*, and for the examination by the custom house officers. Immediately beyond this open space it is customary to erect a shed of at least 30 or 40 feet clear width, in which goods for immediate delivery may lie for a few days, and in which the export goods may be received, if the regulations of the port should be such as to allow the ship to discharge, and receive, cargo on the same berth. The shed is usually succeeded by a wide road, of from 40 to 60 feet, along which the waggons engaged in the service of the dock can circulate; and beyond this road are the warehouses wherein goods are bonded or stored. These warehouses are usually made from 100 to 120 feet wide, and of from one to six stories in height, each of about 11 feet from floor to underside of beams, according to the description of goods they are intended to receive; for it may be as well here to state that tobacco is usually stored in sheds of only one story; sugar (especially the West Indian sugar) is stored in warehouses of three stories; wool is stored in those which have four stories; teas, silks, drugs, spices, &c., in warehouses of about five or six stories. Naturally, however, the number of stories will depend also to some extent upon the value of the ground, and the price of labour in the particular position; for as a general rule it is not desirable to concentrate too much merchandise of value under one roof. The settlement of these details of construction requires great skill, and an intimate knowledge of commercial affairs, in order to secure both economy of construction and of subsequent working.

It may be added that the area of warehouse floor occupied by the various classes of goods varies from 12 feet superficial per ton, of heavy goods, such as sugar in casks piled in two tiers, and including the necessary passages; to about 50 feet superficial per ton of wool, cotton, &c., also packed in two tiers. Wines and spirits are better kept in cellars than above ground; but wherever they are kept, precautions must be observed to maintain a constant temperature around them, and to prevent accidents by fire. In the London Docks, no artificial lights are allowed to be introduced into the spirit cellars or stores.

Beyond the warehouses thus described, it is desirable to form a roadway, at least 60 feet wide, for the waggons which are to receive the goods cleared for consumption, and for any connection with the general railway system of the country which may be desired. The whole of these roads, warehouses, basins, &c., should be surrounded by a wall of at least 20 feet in height.

The St. Katherine's Dock, and the Albert Dock of Liverpool, have been constructed upon principles rather different from those described above, for the warehouses are carried up perpendicularly from the edges of the quays, without any intermediate sheds and roads. This modification was rendered necessary, in the case of St. Katherine's Dock especially, by the extraordinary value of the land on which it was built; but unquestionably the manipulation of the merchandise, under these circumstances, is carried on at a greatly enhanced cost, and with great confusion. In the St. Katherine's Dock there are in some of the warehouses also seven stories (counting the entresol as one); but it is worthy of remark, that merchants have so great an objection to the use of the upper story that practically it is of no value. A very important condition to be observed in the construction of dock warehouses is, that the ventilation should be entirely under control; for if the circulation of air be too rapid, a dessication, and a consequent loss of weight, in the merchandise would take place; whilst, on the other hand, if the air were kept stagnant, some classes of goods would deteriorate.

In docks more especially devoted to the purposes of the timber trade very different arrangements are required from those above described. As the ordinary baulk, fir timber, is supposed to improve by being kept for a certain time afloat, the water surface of timber docks must be made greater than usual, in order to allow the timber to be rafted. The deals and planks require a considerable area for piling, but they do not require any sheds; and the ordinary manner of unloading them, namely, through ports in the bows of the ship, renders necessary a trifling modification in the form of the quay walls. Mahogany and fine furniture woods, however, require to be stacked under sheds, and those of the West India Docks may be cited as models for this class of structure: they contain a series of moveable cranes, erected by the late Mr. J. Rennie, which might even now serve as valuable lessons to engineers and machinists.



St. Katherine's Docks.

It must be distinctly understood that the remarks above made upon the practical details of dock construction, are made with reference only to the circumstances of the day (1859); and it may be interesting to call attention to some of the circumstances which have already modified to a serious extent the technical laws affecting these matters. Thus, the West India and the London Docks were originally built at a time when the existence of a state of war rendered it necessary for merchant vessels to sail in convoys, and they frequently arrived in the Thames, under those circumstances, in great numbers. It was therefore necessary to make the water surface of the docks larger, in proportion to the development of quay front, than would have been necessary in time of peace, in order to be able to receive at once the whole fleets of a season. On the declaration of peace, it was found that the basins were too wide, and in some cases temporary jetties were run into them to increase the berth room; but upon the inauguration of Sir R. Peel's free-trade policy, the great water surface of these docks assumed a fresh value, from the fact that vessels laden with corn, rice, and other grains admitted free of duty, were obliged to unload into barges in dock, because the swell of the steamers in the open stream damaged the cargo. Under all these ever-varying circumstances, it would seem, nevertheless, that the most rational dimensions for parallel basins intended to receive ordinary sailing ships are, that the width should be made about from 500 to 600 feet, and the length about three or four or even six times the width.

The entrance locks of the docks at London vary in width, according to the traffic they are specially designed to accommodate, from 40 feet, to as much as 90 feet in the case of the new Victoria Docks. For ordinary shipping purposes a width of 48 feet, and a constant depth of water of 23 feet over the cills will suffice, and the enormous width of the Victoria Docks can only be required for the reception of sea-going paddle-wheel steamers. The clear length between the points of the gates likewise varies between 100 and 300 feet; but the length of the entrance to the East India Dock, 210 feet, seems to afford a very fair average. As to the quay walls, they may be built either with a curvilinear batter, in the style usually adopted by English engineers, or with a straight batter, as upon the continent; in both cases the versed sine is ascertained by making the average inclination equal to one in eight. The various communication bridges should be made to open in such a way as to interfere as little as possible with the rigging of the ships moving in the docks; and for this reason *turning* bridges are preferable to *lifting* bridges, or to those which are called *bascule* bridges. These remarks about the interference with the rigging will of course apply throughout the whole details of dock construction; and, indeed, the injury which is often done to the masts and yards of vessels lying in the St. Katherine's Dock, is one of the most serious objections to the system of erecting the warehouses on the edge of the quays.

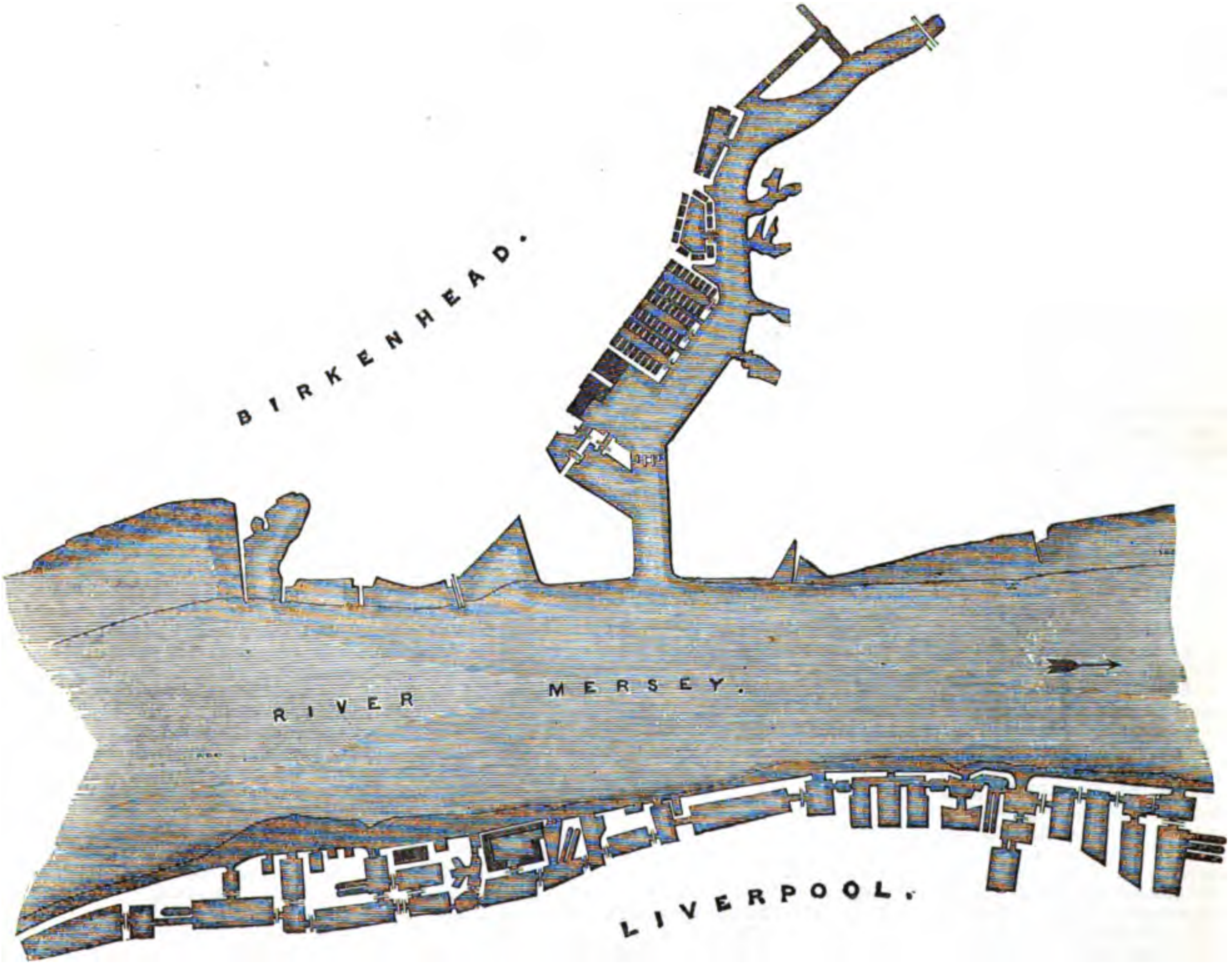
The quay walls must be protected by means of fender piles to prevent the ships from injuring the masonry as they rise and fall. A very solid heavy coping must be placed on the walls; bollards, or mooring posts, should be fixed at about every 50 feet apart; and a crane of about 5 tons power, and a water-cock or hydrant, placed at distances of 200 feet apart. It would be advisable, especially in a long dock, to make occasional provision for a ladder or staircase to the water's edge, in order to allow communication by boats between one side of the dock and another. In docks where repairs of ships are habitually executed, it may be necessary to devote a portion of the water and of the quay surface to this purpose, and to provide *shear-legs, masting-tackle, gridirons* or *caulking-lumps*, with the necessary furnaces for melting pitch and tar. Under all circumstances these latter furnaces must be kept at a considerable distance from the vessels in dock, and it is impossible to attach too much importance to the precautions to be observed for the prevention or for the extinction of fires. In the most recently-constructed docks for the reception of the coal traffic, the hydraulic lift has been largely employed; and, indeed, it has likewise been introduced in the working of the goods warehouses, both of the London and of the Liverpool docks.

Vessels entering docks, of course, do so under the direction of the dock-master. There is at the entrances of the London Docks a clear space left in the river (with a radius of 200 yards), where the companies place dolphins, or hauling buoys, to facilitate the manœuvres of the vessels about to enter. A red flag is hoisted at the pier head when it is time for the vessels to prepare to come in, and a blue flag is hoisted to show that the passage is free. Directly the ebb begins to make strongly, the blue flag is struck: when this is done, no vessel is allowed to enter until the next tide without a special order; vessels coming in have the precedence over those going out. All the manœuvres attending the entrances of the ships are performed by their own crews; and the captains are bound to see that the anchors are ataught, the boats on deck, the bowsprits run in, the yards set up and down, and generally that every precaution is taken to occupy as little space as possible. The regulations with respect to fires, and the working of the ships in dock, vary in every port; but, as a principle, it is admitted, that if goods are to be warehoused, none but the workmen employed by the dock authorities are allowed to touch them, under the inspection of the Custom-House officers and of the captains of the ships. In the case of goods discharged at once in lighters, *over side*, the dock authorities supply the necessary labour to the captains at a fixed tariff; but this operation is carried on entirely at the risk of the merchandise, and it must be performed with the rapidity required by the dock authorities.

The rates usually charged for the use of docks are: 1. The *landing rate*, which includes the quay rate, the unloading and entry into the stores, or the stowage on the quay, and the loading upon carts if the goods are removed immediately from the Customs scales. 2. The *consolidated rate*, which includes the quay rate, the entry into stores, the examination and repair of casks and packages, the sampling, the weighing on delivery, the certificates of damage, and rent for three weeks from the day of breaking bulk. 3. The *management rate*, which is supposed to cover the expenses of showing the goods to purchasers, and of preparing them for sale. 4. The *rent*, payable by weeks, or by fractions of weeks. From observations made upon the application of the rates of the various London companies, it would seem that they are not very logically arranged, and that the rent, especially, does not cover the expenses connected with it. Generally speaking, however, it may be said that the working expenses of the London docks are equal to about 60 per cent. of their gross receipts, and that they pay, one with another, about 4½ per cent. on the capital invested in them. It must, however, be here observed, that the trade connected with steam-boats does not pay the dock companies more than 2¼ per cent. profit under the ordinary tariffs, and that graving-docks never yield much more than 2½ per cent. on their outlay. The price of the Liverpool Docks was said to have ranged between 24,000*l.* and 36,000*l.* per acre of land inclosed; and in that port it is by no means rare to work as many as from 25,000 to 28,000 tons per acre of water surface per annum, while the proportion in London is only from 5000 to 6000 tons per acre. As an approximate rule, the floor surface of the warehouses may be calculated at the rate of 10 feet superficial for every ton in store; but, as was said before, no invariable rule can be applied in this case. Goods generally remain in warehouse for about three months; but the lighter and more valuable goods remain there the longest.

On account of the great security of the warehouses of the larger and wealthy dock companies, it has been possible to introduce a very important facility for commercial operations by the creation of a class of securities known as *dock warrants*. These are, in fact, acknowledgments on the part of the company that they hold and are responsible for certain quantities of goods specified on the warrant, which is then transmissible by endorsement, and the goods are deliverable to the last holder, unless notice to the contrary should have been legally given. [DOCK WARRANT.]

The system of business adopted at Liverpool is rather different from that of London, even when, as in the Albert Docks, the basins are surrounded by bonding-warehouses; for, as a general rule, the commerce of the former town is carried on by means of basins, and of private warehouses in the upper part of the town. In the new Victoria Docks also, some modifications of a rather doubtful value have been introduced, which may be understood by reference to the accompanying cut. Almost every important port in England can now boast of its docks, and the details of them are so necessarily modified by local circumstances that it would be impossible to discuss them in a general article.



Plan of the Liverpool Docks.

DOCK-WARRANTS, are orders by the owner of goods which are lying at a wharf or in a warehouse, upon the wharfinger or warehouseman, to deliver up the goods, or a named portion of them, to the person or persons in whose favour the orders are made. Then if the owner wishes to sell the goods, or portion of them, he may, by handing the dock-warrant to the buyer, made out in his favour, transfer to him the right of obtaining the goods from the wharfinger or warehouseman; so the buyer, by endorsing to a sub-buyer, may transfer to him, and so on; but not so as to be enabled, without something more takes place, to bring an action against the wharfinger, &c., in case of refusal by him to deliver according to the warrant. These warrants, or delivery orders (as they are sometimes called), have the quality of securities, for they represent the goods themselves; and the warehouseman, accepting the order, and not refusing compliance on the ground that he holds the goods subject to an unsatisfied lien of his own against the original owner, or otherwise declining the order, becomes the agent of the buyer, and the buyer holding this order or warrant has the same right to go into the market and sell as if he had the goods in his pocket. Exceptions to, or modifications of, the rule may occur in cases of bankruptcy, insolvency, or when anything remains to be done with the goods before they are in such a state as to identity and quantity as the buyer bargained to have them delivered in; but the above is the general rule. In general, also, the right of lien which the seller has against the buyer is not made away with by giving a dock-warrant or delivery-order.

The wharfinger or warehouseman is liable to an action if he refuses to comply with the dock-warrant or delivery-order and hand over the goods, provided he has signified his acquiescence in the order when it was first presented to him, or have accepted rent, &c., or done any other act so as to have assumed the character of wharfinger to the person suing.

Various statutes have been passed for the better protection of persons making advances of money on goods, &c., on the security of documents of title of this kind, the last of which is the 5 & 6 Vict. c. 39; and see 12 & 13 Vict. c. 106, s. 179.

DOCTOR, one who has taken the highest degree in the faculties of Divinity, Law, Physic, or Music. In its original import it means a person so skilled in his particular art or science as to be qualified to teach it.

There is much difference of opinion as to the time when the title of Doctor was first created. It seems to have been established for the professors of the Roman law in the University of Bologna, about the middle of the 12th century. Antony à Wood says, that the title of Doctor in Divinity began at Paris, after Peter Lombard had compiled his Sentences, about the year 1151. (‘Hist. and Antiq. Univ. of Oxford,’ 4to. Oxf. 1792, vol. i. p. 62.) Previously, those who had proceeded in the faculties had been termed Masters only. The title of Doctor was not adopted in the English Universities earlier than the time of John or Henry III.

In Oxford the time requisite for the Doctor of Divinity's degree is eleven years from the time of matriculation, or four years from the time of proceeding B.A. Doctors of Civil Law, four years after proceeding through Arts, or if intending to practise in the Ecclesiastical Courts; if not, five years from the date of admission as B.C.L. For the degree of M.D., three years must intervene from the time of the candidate's having taken his Bachelor of Medicine's degree. For a Doctor's degree in Divinity or Law three distinct lectures are to be read in the schools, upon three different days: but by a dispensation, first obtained in convocation or congregation, all three are permitted to be read upon the same day; so that by dispensation a single day is sufficient in point of time for these exercises. For a Doctor's degree in Medicine, a dissertation upon some subject, to be approved by the Professor of Medicine, must be publicly recited in the schools, and a copy of it afterwards delivered to the Professor. The University fee on admission is 40*l.*

In Cambridge a Doctor of Divinity must be a Bachelor of Divinity of five, or a M.A. of twelve years' standing. The requisite exercises are one act, two opponencies, a Latin sermon, an English sermon, and a determination. A Doctor of Laws must be a Bachelor of Laws of five years' standing. His exercises are two acts and one opponency. Doctors of Medicine must be Bachelors of Medicine of five years' standing, or a M.A. of seven years' standing. The exercises are two acts and one opponency. For the degree of D.D., the total fees are 51*l.*; for LL.D., 25*l.* 10*s.*; for M.D., 15*l.* 10*s.* For a Doctor's degree in music, in both Universities, the exercise required is the composition and performance of a solemn piece of music, to be approved by the Professor of the Faculty. (‘Oxf. and Camb. Calendars,’ for 1859.)

Coloured engravings of the dresses worn by the doctors of the several faculties of Oxford and Cambridge will be found in Ackermann's ‘History of the Univ. of Oxford,’ 4to, 1814, vol. ii. p. 259, et seq.; and in his ‘History of the Univ. of Cambridge,’ 4to, 1815, vol. ii. p. 312, et seq.

DOCTORS' COMMONS, the College of Civilians in London, near St. Paul's Churchyard, founded by Dr. Harvey, Dean of the Arches, for the professors of the civil law. The official residences of the judge of the Arches' Court of Canterbury, of the judge of the Admiralty, and the judge of the Prerogative Court of Canterbury while it existed, were situated there; and it was the residence of the doctors of the civil law practising in London, who live there (for diet and lodging) in a collegiate manner, and common together. Doctors' Commons was burnt down in the fire of London, and rebuilt at the charge of the profession, whose modern representatives have been authorised to sell the property. [Arches, Court of.]

DODE'CAGON, a figure of twelve sides; a term generally applied to an equiangular and equilateral (or regular) dodecagon. [Regular Polygon.]

DODECAHEDRON. [Solids, Regular.]

DOEGLIC ACID ($C_{38}H_{36}O_4$). An oleaginous acid, extracted from the oil of a species of sperm whale, *Balæna rostrata* (Danish Dögling). It solidifies at 62° Fahr.

DOGE was the title of the first magistrate of the republic of Venice. The first settlers on the islands of the lagune were governed by magistrates sent from Padua. After Padua was devastated by the Huns and other barbarians, A.D. 452-60, the colonists of the lagune being left to themselves, each island elected a magistrate called tribune. An annual selection was made of seven from among these tribunes, who constituted the government of the whole community. A council of forty persons chosen by the general assembly of the people had the legislative and judicial powers. As population and wealth increased, and the community was threatened by hostile neighbours, it was found necessary to concentrate and strengthen the executive, and a chief magistrate for life was elected by the assembly of the people, and was called doge, a corruption of dux, as he was also general of the armed force. The first doge, Paolo Luca Anafesti, was elected in 697. The third doge in succession, Orso Ippato, elected in 724, made war against the Longobards, and took Ravenna, which he restored to the Byzantine emperor, who, as a reward for this service, granted to the republic a tract on the coast of the mainland as far south as the Adige. This first continental possession of Venice, being afterwards enlarged, was called Dogado. The successes of Orso inspired the people with jealousy, and he was assassinated in 737. The office of doge was at the same time abrogated, and an annual magistrate was substituted; but the fifth of these was imprisoned on some charge, and his eyes were put out, after which the people again elected a doge for life in 742. From that time till 1172 about forty doges ruled in succession, nearly one half of whom died a violent death, or were deposed, exiled, or had their eyes put out, sometimes by regular trial before the council of forty, and sometimes by popular insurrection. The Quarantia, or Council of Forty, which exercised the government during the interregna, assumed by degrees the power of electing a doge, in order to put a stop to the frequently recurring tumult and anarchy; the choice, however, was subject to confirmation by the assembly of the people. The first doge thus elected was Sebastiano Ziani, in 1173, and the Forty made him swear to a new constitution, or fundamental law, by which, instead of the general assembly of the people, the sovereign power was vested in a great council of 480 citizens, elected for one year, but capable of indefinite re-election. These were chosen by twelve tribunes, two for each sestiere, or district, of the city of Venice alone, who were themselves appointed by the inhabitants of their respective districts, the other islands and territories of the republic having no part in the elections; each tribune naming forty members. The Great Council was to appoint six individuals who were to be the doge's counsellors, without whose concurrence no act of the doge should be valid. This council was afterwards called "la Signoria." In important cases the doge was to consult with another council of sixty members, called Pregadi, or "requested," taken also from the Great Council. The citizens of Venice, weary of tumult, and being secured in the exclusive right of furnishing the members of the Great or Sovereign Council, seem to have willingly acquiesced in these constitutional changes, and a distribution of golden pieces made by the new doge served to gratify the populace. About a century after, another organic change took place. Pietro Gradenigo being elected doge in 1289, by the influence of the old or aristocratic families, proposed a law which passed the Great Council in 1298 after much opposition and delay, that no one should in future be eligible to sit in that assembly except those who then had a seat in it, or whose fathers, grandfathers, and great-grandfathers, had been members of it. The number of the members of the Great Council was no longer limited to 480. Lastly, in 1319, a new law passed the Great Council, by which that assembly declared itself permanent and hereditary, all the members who were then sitting in it (about 600 in number) remaining for life in possession of their seats, their sons who were above twenty-five years of age being likewise admitted, and their descendants after them, to the exclusion of all other families. This decree, known in history as "la serrata del maggior consiglio," established an hereditary and exclusive aristocracy at Venice, which lasted till the end of that republic. The celebrated Council of Ten was also then appointed, which, though at first only named for two months, gradually appropriated all the power of the state. The confirmation of the doge by the people was henceforth dispensed with. The doge himself became merely a state pageant, the servant of the councils, which had the power of trying and deposing him, and even sentencing him to death. They took away from him the command of the military and naval forces, his children were excluded from every office of state, and he had no patronage except the prebendal stalls of the cathedral of St. Mark. The doge was president by right of all the councils, with a double, or casting vote. He was simply addressed by the title of Messer Doge. (‘Memori Venete’ di Giovanni Gallicioli, Venice, 1826; Daru, ‘Histoire de Venise,’ books 6 and 39.)

The doges at Genoa were at first magistrates for life [Boccanera, in Biog. Div.], as at Venice, but the frequent contentions and civil factions among the aspirants to that dignity induced Andrea Doria, in his reform of 1528, to make the office of doge to last only two years. [Doria, in Biog. Div.]

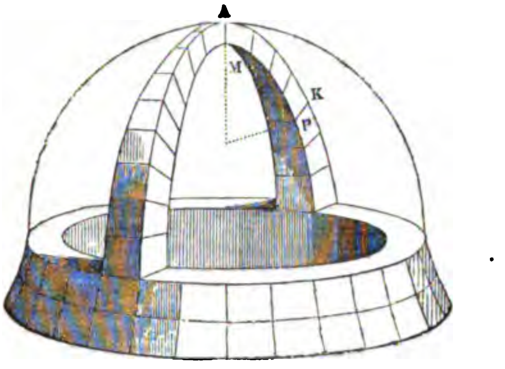
DOGMA (*δόγμα*), a word borrowed from the Greek, means an established principle, a fundamental article of belief derived from undisputed authority, and is generally applied to the essential doctrines of Christianity which are drawn from the Scriptures, or from the authority of the Fathers. Hence that branch of divinity called dogmatic theology is an exposition and assertion of the various articles of the Christian faith as founded upon authority acknowledged by Christians in general, and is distinguished from scholastic theology, which assumes to establish the truth of the Christian doctrines by argument. John Damascenus was one of the first who wrote an exposition of Christian dogmatics. [Damascenus, in Biog. Div.] But although the authority of the Scriptures and of the early fathers is acknowledged by all Christians, there are other authorities which are acknowledged only by one communion, and not by others. Thus the Greek church acknowledges the authority of the earlier councils only, while the Roman Catholics look upon the later councils and the bulls and decretals of the popes as equally positive authority in matters of faith; and the Protestant and reformed churches, rejecting the latter, recur to their respective synods and confessions of faith. Melancthon wrote a concise exposition of the dogmas of the Protestant or Lutheran church. Among the numerous Roman Catholic writers on dogmatic theology, Bellarmine is one of the most distinguished. Dogmatic theology, as distinct from scholastic as well as from moral theology and Biblical divinity, constitutes a separate chair in several Roman Catholic universities in continental Europe, and in those of Ireland.

In the Protestant universities of Germany there is a chair for the history of dogmas. The business of the professor is to examine the doctrines of the various sects which have divided Christianity, their sources, and the arguments by which they are supported. Such a course of lectures forms an important addition to the study of Ecclesiastical History.

DOIT or DUYT, a small Dutch copper coin, being the eighth part of a stiver, in value half a farthing. Doit is also a division of the English grain Troy. See Snelling's 'View of the Coins of Europe,' 8vo. London, 1766. The word is used by Shakspere, 'Coriolanus,' Act i., sc. 5.

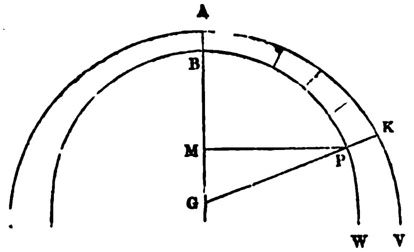
DOLLAR. [MONEY.]

DOME. The mathematical theory of a dome, so far as considerations requisite for security are concerned, is more simple than that of an arch. Imagine two vertical planes passing through the axis of a dome, and making a small angle with each other. These planes intercept (as in the cut) two symmetrically opposite slices of the dome, which tend to support each other at the crown. This support might be made complete and effectual upon principles explained in the article ARCH; so that in fact each small slice of the dome, with its opposite, might compose a balanced arch. Any slice of such a dome is supported by the opposite one only, so that all the rest might be taken away. Now suppose such a dome to be constructed upon an interior centering, of which however the arches are not separately balanced, in consequence of the weight of A P K being so great that the resultant of this weight and the horizontal thrust at A falls obliquely, not being, as in a balanced arch, perpendicular to P K, but cutting the line K P produced towards the axis. Still this dome cannot fall: for since every part of the horizontal course of stones has the same tendency to fall inwards, these pressures inwards cannot produce any effect, except a lateral pressure of each slice upon the two which are vertically contiguous. Hence the condition of equilibrium of a dome is simply this, that the weight of any portion A M P K must be too great for a balanced arch. Upon the same principle a dome may even be constructed with a concave exterior: and in a dome of convex exterior a portion of the crown may be removed, as is the case when the building is surmounted by a lantern. The tendency of the upper part to fall inwards being equal all round, each stone is supported by those adjacent.



From the preceding it appears that it would be (in comparison with an arch) easy to construct a dome with perfectly polished stones, and without cement. The friction of the stones and the tenacity of the cements are of course additional securities. The part in which the construction is weakest will be near the base, more particularly if the joints become nearly horizontal at the base, or if the circumference at the base be very considerable. This weak point is generally secured in practice by bringing strong chains or hoops round the horizontal courses at the interior of the base. Dr. Robison says, "The immense addition of strength which may be derived from hooping largely compensates for all defects; and there are hardly any bounds to the extent to which a very thin dome vaulting may be carried when it is hooped or framed in the direction of the horizontal courses." This system of internal hooping is every way preferable to reliance upon cements, and may, without interference with the ornamental part of the design, be carried to any length. Among other advantages, a dome may be made by means of it to rise vertically from the base, which cannot be the case in an arch.

The thickness of a dome should increase towards the base. A perfectly spherical dome, that is, a segment of a hollow shell cut off by a plane, and therefore of uniform thickness, will stand securely if the arch of the generating circle subtend at the centre less than 51° 49′. The law of the thickness necessary to secure equilibrium is as follows:—



Let the dome be formed by the revolution of A V and B W, and let P K, the joint of one of the stones, be always perpendicular to the interior curve; which is usually the case in practice. Let A M $= x$, M P$=y$, P K$=z$, arc B P$=s$; and let p be any constant *greater than unity*, and A any constant whatever. Then there will be equilibrium, the equation of B P W being given, if

$$z = \frac{Ap}{y}, \left(\frac{dx}{dy}\right)^{p-1} \cdot \frac{d}{ds}\frac{dx}{dy}$$

or e being the angle K G B, and ρ the radius of curvature at P

$$z = \frac{Ap\,(\tan e)^{p-1}}{py\cos^2 e}$$

For the demonstration of this formula, see Venturoli's 'Mechanics' (Creswell's translation), or Robison's 'Mechanical Philosophy.' It is not necessary that p should be a constant: a reference to the work first cited will show how to proceed on the supposition that it is a function of x greater than unity.

It is to be observed, however, that the mathematical theory of dome construction is utterly inapplicable to the extraordinary works of the Mohammedan architects, in which the curve of the dome itself is often carried considerably beyond the points of support. Evidently in such buildings as the Madrissa of Sultan Hussein at Ispahan, the Taj Mehal at Agra, or the tomb of Mahomet at Beejapore, given by Mr. Fergusson in his 'Handbook of Architecture,' the stability of the domes depends entirely upon the adhesion of the materials themselves; for if they had been free to move under the influence of gravity the domes must have fallen.

DOME (in Architecture). A term usually applied in England to express what more properly should be called a "cupola," or a spherical covering of a building or hall. The confusion in the use of this word seems to have arisen from the fact that the Italians and the Germans call the cathedrals, or principal churches of their towns by the generic name duomo, or dom, from the Greek Δωμα, as being *the* houses by way of distinction; and from the additional fact that the majority of the churches or cathedrals built in Italy since the revival of literature have been built with cupolas. It would now be impossible to bring the word back to its original signification, and it may therefore be considered that the term *dome* expresses generically the spherical or the spherico-polygonal coverings of buildings, whether the plans of those buildings be circular or not; that is to say whether the spherical coverings be raised over a rotunda, or over a drum carried down by pendantives to a square base. Specifically the term *dome* expresses the outer, or the convex, side of the covering; whilst that of *cupola* expresses the inner, or the concave side.

Neither the Assyrians, Egyptians, nor the Greeks appear to have resorted to domical construction, although there were some rude attempts occasionally made by the latter nation, as in the treasure chamber at Mycenæ, to carry out that mode of vaulting. The Etruscans seem to have been the first people who habitually employed the dome, and they very frequently adopted it in their tombs or their votive monuments. It was no doubt from them that the Romans derived this style of ornamentation; and it is certain that the most numerous ancient ruins of domes are to be found in the neighbourhood of Rome and Naples. The principal of these in and near Rome are the Pantheon and the temples of Bacchus, Vesta, Romulus, Hercules, Cybele, Neptune, and Venus, and also some of the chambers of the Thermæ.

The most magnificent dome of antiquity is unquestionably that of the Pantheon, supposed to be a chamber of the great baths of Agrippa. The diameter of the dome internally is 142 feet 8¼ inches, with a circular opening at the top in the centre 28 feet 6 inches in diameter. The height of the dome from the top of the attic is 70 feet 8 inches. Internally it is decorated with five rows of square compartments. Each row is considerably larger than that immediately above it, as they converge towards the top. The large squares, all of which are rather more than 12 feet each way, contain four smaller squares sunk one within the other. It is supposed that these squares were decorated with plates of silver, from some fragments of that metal having been found on them. The opening at the top of the dome was decorated with an ornamented bronze moulding, gilt. The external part of the dome appears also to have been decorated with bands of bronze. Constantius II. removed the silver and bronze with which the building was decorated. The base of the dome externally consists of a large plinth with six smaller plinths or steps above it; and in the curve of the dome a flight of steps is formed which leads to the opening at the top of the dome. From the drawings of the architect Serlio it appears that flights of steps were formed at intervals all round the dome, which are now covered with the lead placed there by order of Urban VIII. The dome is constructed of bricks and rubble. Sunk bands round the hollow squares or caissons appear to be formed in brick, and the other parts in tufo and pumice stone. The thickness of the dome of the Pantheon is about 17 feet at the base, 5 feet 1½ inches at the top of the highest step, and 4 feet 7 inches at the top of the dome. The circular wall which supports the dome is 20 feet thick. This wall is however divided by several large openings, and is furnished with discharging arches of brick. It is most probable that the dome of the Pantheon was executed by means of a centering of wood with the hollow squares formed in relief upon it, as was afterwards done in constructing the great vaulting of St. Peter's.

The dome of one of the chambers of the Thermæ of Caracalla was 111 feet in diameter. In the Thermæ of Titus there are two domes each 84 feet in diameter, and in the baths of Constantine there was one of 76 feet. There were three domes in the baths of Diocletian, of which two still remain; one is 73 feet 6 inches in diameter, and the other 62 feet 3 inches. Judging from those that remain, there is every reason to believe that in the Thermæ they were all lighted from above, like the dome of the Pantheon. Near Pozzuoli there is a very perfect circular building, with a dome 96 feet in diameter, built of volcanic tufo and pumice stone. The temple of Minerva Medica, without the walls of Rome, was on the plan of a polygonal dome of ten sides built of brick and pumice stone. This building does not appear to have had any opening at the top.

The ancients appear to have constructed domes on corbels. At Catania there is a spherical dome which covers a square vestibule; and in one of the octagonal rooms of the enclosure surrounding the baths of Caracalla the corbels still remain which most probably supported the dome of the chamber.

The dome of Santa Sophia, at Constantinople, built in the reign of Justinian, is the most remarkable and the earliest constructed after those of the Romans. Anthemius of Tralles and Isidorus of Miletus were the architects. The present dome, however, was reconstructed by the nephew of Isidorus. It rests on the square formed at the intersection of the arms of the Greek cross: the diameter is about 111 feet, and the dome 40 feet high. The dome is supported by four corbellings placed in the angles of the square. The corbels are surmounted by a kind of cornice which supports a circular gallery. The lower part of the dome is pierced with a row of small windows adorned with columns on the exterior. Externally the dome is divided by projecting ribs, rounded and covered with lead. The top is surmounted by a lantern or finishing like a baluster, on which is a cross. The dome of Anthemius and Isidorus was not so high, and was partly destroyed twenty-one years after its construction by an earthquake during the lifetime of Justinian. In the reconstruction the nephew of Anthemius used very light white bricks, only one fifth the weight of common bricks, which are said to have been made in Rhodes. It appears from the history and description of the building of Santa Sophia, by Procopius, that the architects encountered many difficulties, which arose probably from not being thoroughly acquainted with the principles on which domes should be constructed. (Procopius, *περὶ κτισμάτων*, lib. i. cap. 1.)

The dome of San Vitale, at Ravenna, which is considered to be more ancient than that of Santa Sophia, is curiously constructed. The lower part of the plan of the dome is a regular octagon, which is supported by eight piers placed at the angles of the dome. Between these angles are seven tall niches divided into two stories. The lower part of these niches is open, and ornamented with columns, like Santa Sophia. The eighth side of the dome is pierced with a great arch forming an entrance. This arch is of the same diameter and the same elevation as the niches. The wall above the niches and arch, which is without openings, sustains a hemispherical dome, the plan being a circle described within a regular octagon. Corbels are not employed as at Santa Sophia, but the arches support the gathering over, or corbelling, which forms the circular base of the dome. The base of the dome is pierced with eight windows, each divided in the middle by a column which supports two small arches. The dome itself is built with a double row of pipes, hollow at one end and pointed at the other, the point of one being placed in the hollow of the preceding. They are thus continued in a gentle spiral line until they finish at the top. Between the top of the small arched windows and the pipes there is a construction formed with vases, not unlike the system adopted in the circus of Caracalla. The dome itself is covered with mortar both within and without.

The church of San Marco at Venice, built in the 10th century, by order of Pietro Orseolo, the then doge, is decorated with five domes. One of these, placed in the centre of the church, is much larger than the others. Each dome is enclosed within four pieces of semi-cylindrical vaulting, together forming a square, in the angles of which are four corbels, which gather in the circular base of each dome. The lower part of the dome is pierced with small windows. The interior is covered with mosaic, and the top of the dome is terminated with a finishing on which is a cross. In 1523 the doge, Andrea Gritti, caused the domes to be repaired, and Sansovino, the architect, restored in a great measure the supports, and placed (at about one-third of its height) a great circle of iron round the large dome to prevent its falling; a precaution which has been completely successful. The other domes are not so well preserved. In 1729 one of the smaller domes was in danger of falling, from the decay which had taken place in a circular bond placed at the base of the dome. Stone was however substituted for the wooden bond, and a circle of iron placed without the dome near its base. In 1735 Andrew Tirali, the architect to the church, placed an iron circle round the dome which is near the great gate, on account of some small fractures which were then perceived. If, however, the other domes are constructed with a wooden bond, it is very probable that they will eventually fall unless steps be taken in time to remove the timber. By the use however of corrosive sublimate, now used in Kyan's patent for preserving wood from the dry rot, wood may be used in the construction of domes with much more security as regards durability.

The celebrated dome of Santa Maria del Fiore, built by Bruneleschi, is far superior in construction to the domes of Santa Sophia and San Marco. Bruneleschi first constructed the octagon tower which supports the dome. Each face of the tower is pierced with a circular window; the walls are 17 feet thick, and the cornice which terminates the tower is 175 feet from the ground. From this cornice rises the double dome. The outer dome is 7 feet 10 inches thick at the base. The internal dome, which is connected at the angles with the external dome, is 139 feet in diameter and 133 feet high from the top of the internal cornice of the tower to the eye of the lantern. This dome has eight angles, forming a species of Gothic vault, and was the first double dome with which we are acquainted. Some time after the dome was finished, several fractures were perceived in it, which were owing to settlements in the masonry; but the fractures were filled up and no new signs of settlement have showed themselves since.

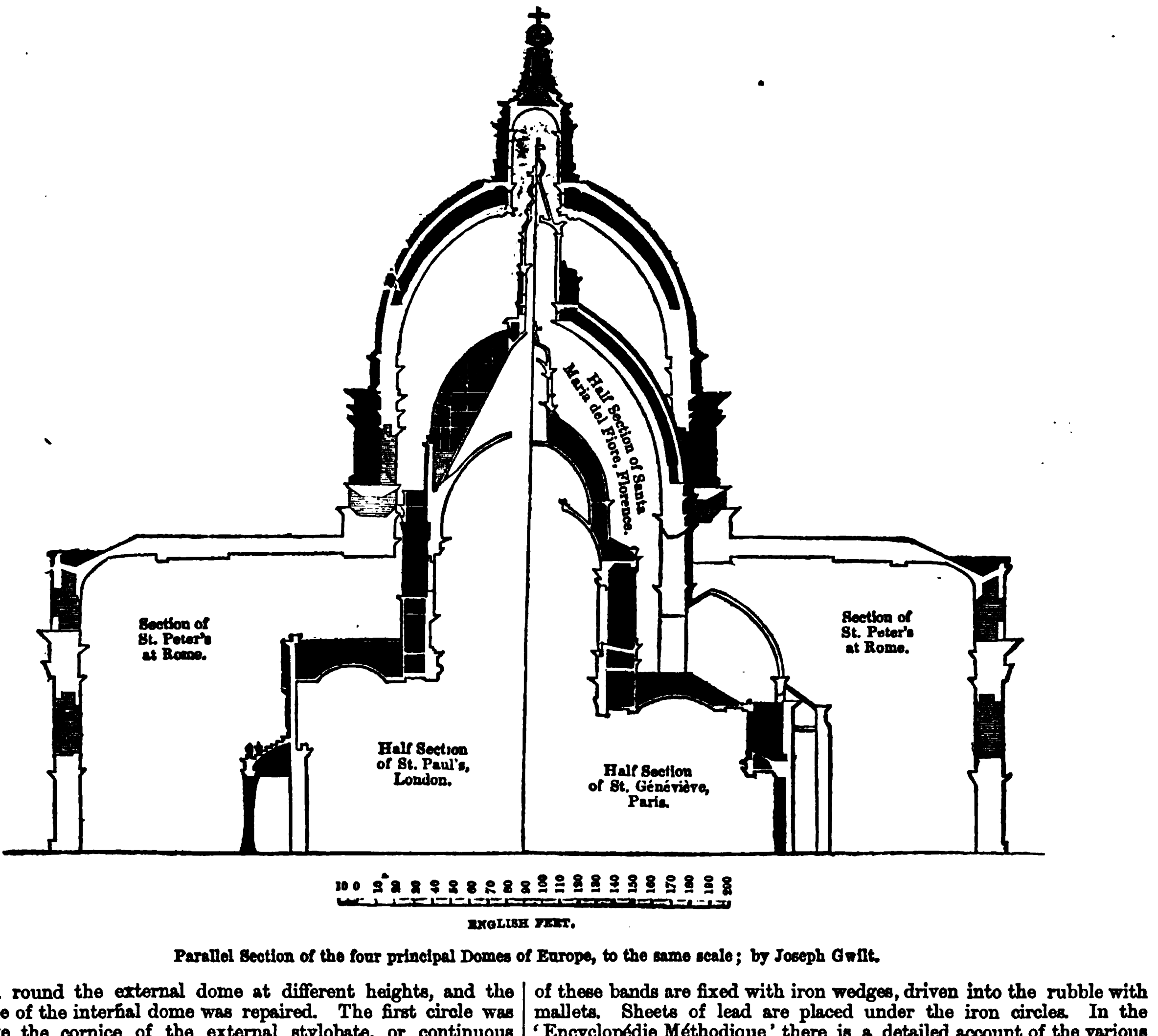
The first modern dome constructed in Rome was that of the Church of Our Lady of Loretto. It was commenced in 1507 by Antonio Sangallo. The dome, which is double, is circular on the plan. The internal dome is constructed on double consoles, instead of corbellings. The double consoles are crowned with a small cornice, forming an impost for eight arches, from the upper part of which springs the dome. On the top is a lantern light, which is not apparent externally.

Up to this time domes had been constructed on walls and corbellings; but in St. Peter's at Rome a new plan was adopted. The dome of St. Peter's stands upon four piers, 61 feet 11 inches high, and 30 feet 10 inches thick, measured in a straight line with the arches. From the arches spring the corbellings, which are finished by an entablature. Upon this entablature is a plinth. The plinth is externally an octagon, and internally a circle. The external diameter of the octagon is 192 feet 9 inches, and the internal circle 134 feet 8½ inches; the thinnest part of the wall, between the octagon and the circle, is 29 feet 3 inches. On the plinth is a circular stylobate, 28 feet 6½ inches thick. This thickness is divided into three parts by a circular passage, 5 feet 10 inches wide: the two walls on each side of this passage are, respectively, the internal wall 14 feet 7½ inches thick, and the external 8 feet. In the internal wall are other smaller passages, 2 feet 10 inches wide, forming flights of steps communicating with the four spiral staircases formed in the thickness of the wall of the drum of the dome. Above the circular stylobate, which is 12 feet 4½ inches high, is placed the drum of the dome, which is 10 feet 1½ inches thick, measured to the inside line of the pilasters, which decorate the interior of the dome. The pilasters themselves are 1·78 feet thick in addition. The construction is formed of rubble and fragments of brick. The interior is lined with bricks stuccoed. Externally the work is faced with thin slabs of travertine stone. The drum is pierced with sixteen windows, 9 feet 3¾ inches wide and 17 feet high. The walls are strengthened on the outside, between the windows, with sixteen buttresses, constructed with solid masonary. These buttresses are 13 feet 3 inches wide and 51 feet 6 inches in height, from the base to the top of the entablature. Each buttress is decorated and strengthened with half pilasters, and terminates with two coupled columns engaged, the diameter of which is 4 feet: the order is Corinthian. When the base of the dome had been built to the height of the entablature of the drum, Michel Angelo died: but some time before his death he had caused a wooden model to be made, with ample details, to which he added drawings and instructions. After his death Pirro Ligorio and Vignola were appointed the architects. Giacomo della Porta, the pupil of Vignola, followed his master as architect to the cathedral; but though the designs of Michel Angelo were strictly followed, the dome itself was constructed under the pontificate of Sixtus V. Sixtus gave Giacomo della Porta as a colleague Domenico Fontana, by whom the dome was constructed.

On the constructions of Michel Angelo a circular attic was first formed, 19 feet 2¼ inches high, and 9 feet 7 inches thick. This attic is strengthened externally by 16 projections, 2 feet 11 inches deep, and 6 feet 4½ inches wide, placed over the buttresses of the dome. On the attic rises the double dome, the internal diameter of which, at the base, is 138 feet 5 inches. The curve externally is an arc of a circle whose radius is 84 feet 1·62 inches. To the height of 27 feet 8 inches from the attic the dome is solid. At the base the thickness is 9 feet 7 inches; and as the external dome is raised higher than the internal dome, the thickness is increased as the curve ascends, so that where the dome is divided the thickness is 11 feet 4 inches. The circular space which divides the two domes is 3 feet 2¼ inches wide; the internal dome is 6 feet 4 inches thick; and the height from the attic to the opening of the lantern is 83 feet 10 inches. The diameter of the lantern is 24 feet 10 inches. The external dome is 2 feet 10⅛ inches thick where it separates itself from the internal dome; and it is strengthened externally by 16 projecting bands of the same thickness. The dome is pierced with three rows of small windows. As the curves of the dome are not concentric, the space between them becomes wider as it rises; so that at the opening of the lantern the space is 10 feet wide. These domes are joined together by 16 walls or spurs, diminishing in thickness as they ascend to the lantern; at the base they are 8 feet thick, and at the summit 3 feet. The base of the lantern is arched, and pierced with small windows. Above the two domes is a circular platform, surrounded with an iron gallery. In the centre rises the lantern, on a stylobate broken into 16 parts, forming projecting pedestals, above which are buttresses similar to the buttresses of the drum, decorated externally with coupled Ionic columns, 17⅛ inches in diameter. The space between the buttresses is filled with arched openings, which give light to the lantern. The external diameter of the lantern is 39 feet; the internal diameter 25 feet 11 inches; and the height from the platform to the top of the cross is 89 feet 7⅛ inches. The whole height, from the external plinth of the dome to the cross, is 263 feet. The total height from the pavement is 437 feet 5 inches. The total height internally, to the top of the dome of the lantern, is 387 feet.

Sixtus V. covered the external dome with lead, and the bands with bronze gilt. One hundred thousand large pieces of wood were used in making the centering of the domes, which was so admirably constructed that it appeared suspended in the air. (See the drawings in the work by Fontana, on the construction of this dome.) This centering was more for the purpose of a scaffolding for the materials and workmen, than to sustain the weight of the double dome. During the construction of the dome it is believed that only two circles of iron were placed round the masonry, one of which was placed on the outside of the internal dome, at about 36 feet from its springing, and one foot above the division of the domes. The bands of iron of which this circle is composed are 3 inches wide by 1¾ inch thick. A similar circle is placed about the middle of the solid part of the dome, at about 17 feet 6 inches above the springing of the internal dome. Near the top of the internal dome there are several holes, at the bottom of which upright iron bars appear. These bars are said to be the connecting rods which keep together other circles of iron placed at different heights within the masonry, which are finally terminated by a circle round the eye of the dome.

The domes were constructed with such haste, that sufficient time was not allowed to the work to take a solid bed as it was carried up, in consequence of which a great number of vertical settlements have occurred, and the circle of iron round the internal dome was fractured. To obviate the danger arising from these settlements, six circles of iron were placed round the external dome at different heights, and the broken circle of the internal dome was repaired. The first circle was placed above the cornice of the external stylobate, or continuous plinth, on which the buttresses stand; the second circle was placed above the cornice of the buttresses, the third above the attic at the springing of the external dome, the fourth half way up the external dome, and the fifth under the base of the lantern. A sixth was shortly after placed at one foot below where the dome divides itself. The iron bands are flat, from 16 to 17 feet long, 3⅛ inches wide, and 2$\frac{1}{12}$ inches thick. At one end of the pieces of iron a hole is made; the other end is turned up and passed through the eye of the next band. The whole of these bands are fixed with iron wedges, driven into the rubble with mallets. Sheets of lead are placed under the iron circles. In the 'Encyclopédie Méthodique' there is a detailed account of the various fractures of the dome, and the means employed to repair them. ('Encyclopédie Méthodique,'—Architecture, article Coupole.)


Half Section of Santa Maria del Fiore, Florence.
Section of St. Peter's at Rome.
Section of St. Peter's at Rome.
Half Section of St. Paul's, London.
Half Section of St. Généviève, Paris.
10 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
ENGLISH FEET.

Parallel Section of the four principal Domes of Europe, to the same scale; by Joseph Gwilt.

The dome of St. Paul's Cathedral, London, is placed over the intersection of the arms of the cross. The ground plan is a regular octagon, each face of which is 44 feet 8¾ inches wide; four of these sides are formed by the four great arches of the naves; the other four sides are formed by false arches of the same size; in each of these arches there is a great niche, the base of which is pierced with two arches. By this means eight supports are obtained instead of four, and the corbellings do not project too much, as in other similar constructions. The corbellings gather in a circle, the diameter of which is 104 feet 4 inches, the octagon base being 107 feet. The corbellings are surmounted by a complete entablature, 8 feet 3 inches high, decorated with consoles. The drum is set back 3 feet 2¼ inches from the face of the frieze, and this intermediate space is occupied by two steps and a seat. The cornice is 98 feet 9¾ inches from the pavement. The height of the drum from the top of the seat is 62 feet 6½ inches to the springing of the internal dome. The wall forming the drum is inclined internally 4 feet 11½ inches, or about the 12th part of its height. This was designed by the architect to increase the resistance of the walls to the united pressure of the large internal vault and the conical dome which carries the lantern.

The interior of the drum is decorated with a continuous stylobate, on which is an order of Corinthian pilasters. The 32 spaces between the pilasters are filled with 24 windows and 8 large niches. Externally the drum is decorated with an order of 32 Corinthian columns engaged, which are united to the wall of the drum by eight solid constructions in masonry. In each space between the constructions there are three intercolumnations, the columns being joined at their bases by walls pierced with arches. The external colonnade is surmounted by an entablature, with a mutuled cornice, on which is a balustrade; behind this is a terrace, formed by the recessing back. The attic is 22 feet 4¼ inches high from the top of the balustrade to the under side of the cornice of the attic. Above the internal order of the drum rises the interior dome, the diameter of which at the springing is 102 feet 2¾ inches by 51 feet in height. The top of the dome has a circular opening 14 feet 10¾ inches in diameter.

Above the attic are two steps, from which the external dome springs. The external dome is constructed of wood, covered with lead, and decorated with projecting ribs forming panels, curved at the ends. This dome terminates with a finishing which joins the base of the lantern; the circular gallery formed on the finishing is 274 feet 9 inches above the pavement of the nave. The lantern is supported on a conical tower, terminated by a spherical dome. This tower, which is joined to the internal dome at its base, disengages itself from it at the height of 8 feet 6 inches above the springing of the same. The perpendicular height of this tower is 86 feet 9 inches, and the walls are inclined 24 degrees from the perpendicular. The diameter of the base is 100 feet 1 inch measured externally, and 34 feet 1 inch at the springing of the spherical dome which finishes it. The wall of this tower is built of brick, and is 1 foot 7 inches thick, with circular rings of masonry, fastened with iron bands. The spherical dome at the top of the tower has an opening 8 feet in diameter at the summit. Between the attic and the wall of the tower are 32 walls or buttresses, which also serve to bear the ribs of the wooden external dome.

About the same time that Wren built the dome of St. Paul's, Hardouin Mansard, a French architect, constructed the dome of the Invalides at Paris. The plan of this dome is a square, in which is inscribed a Greek cross; in the angles of the square there are four chapels. The dome is raised in the centre of the Greek cross; the base supporting it is an octagonal figure, with four large and four small sides. The four small sides form the faces of the piers of the dome; the large sides are the arched openings of the nave and transverse aisles. A circular entablature is placed over the corbellings, and on the entablature is raised the drum of the dome, the diameter of which is 79 feet 9½ inches. The interior of the drum is decorated with a continuous stylobate, above which are coupled pilasters of the composite order, and the wall is pierced with 12 windows. The dome, which is double, rises from a spinging common to both. The lower or internal dome, constructed with masonry, is spherical, and is 83 feet in diameter, with an opening or eye at the top 53 feet 3 inches in diameter, through which part of the outer dome can be seen. The outer dome is of a spheroidal form, and constructed of stone at the base and of brick above. Externally the dome is formed with a stylobate, on which is a Corinthian order of columns, over which is an attic with pilasters, and buttresses in the form of consoles. The drum is fortified externally by eight projections, placed two and two above each pier of the dome. The external dome is framed of wood and covered with lead, like St. Paul's, London, but the construction is much heavier. The external diameter of the dome is 85 feet 4 inches, and its height is 57 feet 2½ inches. The finishing of the dome is decorated with consoles, on which is formed a circular balcony round the base of the lantern, constructed of wood, which is 39 feet 4¾ inches high; the lantern above it, with the cross, is 35 feet 4¾ inches high. The total height from the ground is 330 feet.

The dome of the Pantheon at Paris is constructed entirely of stone, and is placed in the centre of a Greek cross. It is supported by four triangular piers strengthened by engaged columns of the Corinthian order. The four piers with the lines of the intermediate arches form externally a large square, each side of which is 74 feet 9 inches.

These four piers are pierced above with arched openings, and between the piers with the openings are large arches, the diameter of which is 44 feet 11½ inches, and the height 85 feet 5 inches. Between these arches rise the corbellings, which are gathered in to form the circular plan of the drum. The arches and the corbellings are crowned with a large entablature 13 feet 4 inches high. The upper part of the cornice of the entablature is raised 101 feet above the pavement of the nave. The diameter taken at the frieze is 66 feet. The internal drum which is constructed on this entablature is 55 feet 7½ inches in height to the springing of the internal dome. The interior of this drum is decorated with a continuous stylobate, which is the basement of a colonnade of 16 Corinthian columns almost isolated from the wall. These columns are 35 feet 2¾ inches in height. Between the columns are 16 windows, four of which are false, and placed above the four piers of the dome. The colonnade is crowned with an entablature, above which is a large plinth which rises to the springing of the internal dome. The internal dome is 66 feet 8½ inches in diameter at the springing, and is decorated with octagonal caissons or sinkings with a rose in the centre of each. The eye at the top of the dome is 31 feet 3½ inches in diameter. Through this eye is seen the upper part of another or intermediate dome. The external dome is placed on a circular base 108 feet 7½ inches in diameter and square at the bottom. The angles are strengthened by flying buttresses. Above the corbellings a circular wall is constructed, forming an external continuous stylobate which supports an external colonnade. The external colonnade constructed on the stylobate forms a peristyle round the dome, and is composed of 32 isolated columns of the Corinthian order 36 feet 5¾ inches high. This colonnade is divided into four parts by the solid constructions in masonry raised over the four piers. The external colonnade is surmounted with an entablature and balustrade above it. There is an attic constructed above the circular wall of the drum, set back 13 feet 10 inches, and pierced with 16 windows, 12 of which light the space between the internal dome and the intermediate dome which bears the lantern. This attic is terminated with a cornice with a step or plinth above. The external dome, 77 feet 8¾ inches in diameter, measured on the outside, is constructed with masonry; the height is 45 feet 9½ inches from the top of the attic to the underside of the finishing against which the curve terminates. The outside of the dome is covered with lead, and is equally divided vertically by 16 projecting ribs. The intermediate dome, built for the purpose of carrying the lantern, was intended to be decorated with subjects by the painter, and we believe it has since been decorated. The form of this dome resembles the small end of an egg: its springing commences at the base of the attic at the point where the internal dome begins to disengage itself. This dome is 50 feet ¾ inch high, and 70 feet 3½ inches in diameter, and is pierced with four great openings at the lower part 37 feet 3 inches high, and 30 feet 10½ inches wide at the base. On a circular platform above the summit of the dome are eight piers with arches, which support the finishing against which the external dome terminates. Above this is the lantern of the dome.

Very full details of the most remarkable domes in Europe are given in the 'Encyclopédie Méthodique' (article Architecture), from which this brief notice is in a great measure taken. For an account of the construction of wooden-ribbed domes, see Nicholson's 'Architectural Dictionary;' also the section of the Pantheon dome by Taylor and Cressy; also the work on St. Peter's, by Fontana. The dome of the Reading Room of the British Museum is described in the article BRITISH MUSEUM.

The following admeasurements of most of the principal domes of Europe are chiefly from Mr. Ware's 'Tracts on Vaults and Bridges':—

DOMES OF ANTIQUITY.	Feet in diameter taken externally.	Height from the ground line.
Dome of the Pantheon	142	143
„ Minerva Medica at Rome	78	97
„ Baths of Caracalla	112	116
„ Baths of Diocletian	74	83
Temple of Mercury	68	
„ Diana	98	78
„ Apollo	120	
„ Proserpine and Venus	87	77
DOMES OF COMPARATIVELY MODERN TIMES.		
Santa Sophia at Constantinople	115	201
Mosque of Achmet, ditto	92	120
San. Vitale at Ravenna	55	91
Baptistery at Nocera dei Pagani	50	
San Marco at Venice	44	
FROM THE TIME OF BRUNELLESCHI TO THE PRESENT PERIOD.		
Santa Maria del Fiore at Florence	139	310
The Chapel of the Medici	91	199
Baptistery at Florence	86	110
Cathedral of St. Peter at Rome	139	330
Church of the Madonna della Salute at Venice	70	133
„ Superga at Turin	64	128
„ Invalides at Paris	80	173
„ Val de Grace, Paris	55	133
„ Sorbonne, Paris	40	110
Pantheon, or St. Généviève, Paris	67	190
Cathedral of St. Paul's, London	112	215
Reading Room of British Museum	140	106

(Isabelle, *Edifices Circulaires;* Rondelet, *L'Art de Batir;* Fergusson, *Handbook of Architecture.*)

DOMESDAY BOOK, the register of the lands of England, framed by order of King William the Conqueror. It was sometimes termed 'Rotulus Wintoniæ,' and was the book from which judgment was to be given upon the value, tenures, and services of the lands therein described. The original is comprised in two volumes—one a large folio, the other a quarto. The first begins with Kent, and proceeds with other counties in the following order: Sussex, Surrey, Hampshire, Berkshire, Wiltshire, Dorsetshire, Somersetshire, Devonshire, Cornwall, Middlesex, Hertfordshire, Buckinghamshire, Oxfordshire, Gloucestershire, Worcestershire, Herefordshire, Cambridgeshire, Huntingdonshire, Bedfordshire, Northamptonshire, Leicestershire, Warwickshire, Staffordshire, Shropshire, Cheshire, Derbyshire, Nottinghamshire, Yorkshire, and concluding with Lincolnshire. It is written on 382 double pages of vellum, in one and the same hand, in a small but plain character, each page having a double column; it contains 31 counties. After Lincolnshire (fol. 373), the claims arising in the three ridings in Yorkshire are taken notice of, and settled; then follow the claims in Lincolnshire, and the determinations of the jury upon them (fol. 375); lastly, from fol. 379 to the end there is a recapitulation of every wapentake or hundred in the three ridings of Yorkshire, of the towns in each hundred, what number of carucates and oxgangs are in every town, and the names of the owners placed in a very small character above them. The second volume, in quarto, is written upon 450 double pages of vellum, but in a single column, and in a large fair character, and contains the counties of Essex, Norfolk, and Suffolk. In these counties the "liberi homines" are ranked separate; and there is also a title of "Invasiones super Regem."

These two volumes are preserved, among other records of the Exchequer, in the Chapter House at Westminster; and at the end of the second is the following memorial in capital letters of the time of its completion: "Anno Millesimo Octogesimo Sexto ab Incarnatione Domini, vigesimo vero regni Willielmi, facta est itsa Descriptio, non solum per hos tres Comitatus, sed etiam per alios." From internal evidence, there can be no doubt but that the same year, 1086, is assignable as the date of the first volume.

In 1767, in consequence of an address of the House of Lords, George III. gave directions for the publication of this survey. It was not, however, till after 1770 that the work was actually commenced. Its publication was entrusted to Mr. Abraham Farley, a gentleman of learning as well as of great experience in records, who had almost daily recourse to the book for more than forty years. It was completed early in 1783, having been ten years in passing through the press, and thus became generally accessible to the antiquary and topographer. It was printed in fac-simile, as far as regular types, assisted by the representation of particular contractions, could imitate the original.

In 1816 the commissioners upon the public records published two volumes supplementary to Domesday, which now form one set with the volumes of the Record. One of these contains a general introduction, accompanied with two different indexes of the names of places, an alphabetical index of the tenants in capite, and an 'Index Rerum.' The other contains four records: three of them, namely, the Exon Domesday, the Inquisitio Eliensis, and the Liber Winton., contemporary with the Survey; the other record, called 'Boldon Book,' is the survey of Durham, made in 1183, by Bishop Hugh Pudsey. These supplementary volumes were published under the superintendence of Sir Henry Ellis.

Northumberland, Cumberland, Westmoreland, and Durham were not included in the counties described in the Great Domesday; nor does Lancashire appear under its proper name; but Furness, and the northern part of that county, as well as the south of Westmoreland and part of Cumberland, are included within the West Riding of Yorkshire. That part of Lancashire which lies between the rivers Ribble and Mersey, and which at the time of the survey comprehended 6 hundreds and 188 manors, is subjoined to Cheshire. Part of Rutlandshire is described in the counties of Northampton and Lincoln; and the two ancient hundreds of Atiscross and Existan, deemed a part of Cheshire in the survey, have been since transferred to the counties of Flint and Denbigh. In the account of Gloucestershire we find a considerable portion of Monmouthshire included, seemingly all between the rivers Wye and Usk. Kelham thinks it probable that the king's commissioners might find it impossible to take any exact survey of the three counties northernmost of all, as they had suffered so much from the Conqueror's vengeance. As to Durham, he adds, all the country between the Tees and Tyne had been conferred by Alfred on the bishop of this see; and at the coming in of the Conqueror he was reputed a count-palatine.

The order generally observed in writing the Survey was to set down in the first place at the head of every county (except Chester and Rutland) the king's name, *Rex Willielmus*, and then a list of the bishops, religious houses, churches, any great men, according to their rank, who held of the king in capite in that county, likewise of his thains, ministers, and servants; with a numerical figure in red ink before them, for the better finding them in the book. In some counties the cities and capital boroughs are taken notice of before the list of the great tenants is entered, with the particular laws or customs which prevailed in each of them; and in others they are inserted promiscuously. After the list of the tenants, the manors and possessions themselves which belong to the king, and also to each owner throughout the whole county, whether they lie in the same or different hundreds, are collected together and minutely noted, with their under-tenants. The king's demesnes, under the title of *Terra Regis*, always stand first.

For the adjustment of this survey certain commissioners, called the king's justiciaries, were appointed. In folios 164 and 181 of the first volume we find them designated as "Legati Regis." Those, for the midland counties at least, if not for all the districts, were Remigius, bishop of Lincoln, Walter Giffard, earl of Buckingham, Henry de Ferrers, and Adam, the brother of Eudo Dapifer, who probably associated with them some principal person in each shire. These inquisitors, upon the oaths of the sheriffs, the lords of each manor, the presbyters of every church, the reves of every hundred, the bailiffs and six villains of every village, were to inquire into the name of the place, who held it in the time of king Edward, who was the present possessor, how many hides in the manor, how many carucates in demesne, how many homagers, how many villains, how many cotarii, how many servi, what free-men, how many tenants in socage, what quantity of wood, how much meadow and pasture, what mills and fish-ponds, how much added or taken away, what the gross value in king Edward's time, what the present value, and how much each free-man or soc-man had or has. All this was to be triply estimated: first, as the estate was held in the time of the Confessor; then as it was bestowed by king William; and thirdly, as its value stood at the formation of the survey. The jurors were, moreover, to state whether any advance could be made in the value. Such are the exact terms of one of the inquisitions for the formation of this survey, still preserved in a register of the monastery of Ely.

The writer of that part of the Saxon Chronicle which relates to the Conqueror's time, informs us with some degree of asperity, that not a hide or yardland, not an ox, cow, or hog, was omitted in the census. It should seem, however, that the jurors, in numerous instances, framed returns of a more extensive nature than were absolutely required by the king's precept, and it is perhaps on this account that we have different kinds of descriptions in different counties.

It is not necessary to go more minutely into the contents of this extraordinary record, to enlarge upon the classes of tenantry enumerated in it, the descriptions of land and other property therewith connected, the computations of money, the territorial jurisdictions and franchises, the tenures and services, the criminal and civil jurisdictions, the ecclesiastical matters, the historical and other particular events alluded to, or the illustrations of ancient manners, with information relating to all of which it abounds, exclusive of its particular and more immediate interest in the localities of the country for the county historian.

As an abstract of population it fails. The tenants in capite, including ecclesiastical corporations, amounted scarcely to 1400; the under-tenants to somewhat less than 8000. The total population, as far as it is given in the record itself, amounts to no more than 282,242 persons. In Middlesex, pannage (payment for feeding) is returned for 16,535, in Hertfordshire for 30,705, and in Essex for 92,991 hogs; yet not a single swine-herd (a character so well known in the Saxon times) is entered in these counties. In the Norman period, as can be proved from records, the whole of Essex was, in a manner, one continued forest; yet once only in that county is a forester mentioned, in the entry concerning Writtle. Salt-works, works for the production of lead and iron, mills, vineyards, fisheries, trade, and the manual arts, must have given occupation to thousands who are unrecorded in the survey; to say nothing of those who tended the flocks and herds, the returns of which so greatly enlarge the pages of the second volume. In some counties we have no mention of a single priest, even where churches are found; and scarcely any inmate of a monastery is recorded beyond the abbot or abbess, who stands as a tenant in capite. These remarks might be extended, but they are sufficient for their purpose. They show that, in this point of view, the Domesday Survey is but a partial register. It was not intended to be a record of population further than was required for ascertaining the geld.

There is one important fact, however, to be gathered from its entries. It shows in detail how long a time elapsed before England recovered from the violence attendant on the Norman Conquest. The annual value of property, it will be found, was much lessened as compared with the produce of estates in the time of Edward the Confessor. In general, at the Survey, the king's lands were more highly rated than before the Conquest; and his rent from the burghs was greatly increased; a few also of the larger tenants in capite had improved their estates; but, on the whole, the rental of the kingdom was reduced, and twenty years after the Conquest the estates were, on an average, valued at little more than three-fourths of the former estimate. An instance appears in the county of Middlesex, where no Terra Regis however occurs. The first column, headed T.R.E., shows the value of the estates in the time of King Edward the Confessor;

the second, the sums at which they were rated at the time of the Survey, *tempore Regis Willielmi.*

	T.R.E.			T.R.W.		
	£	*s.*	*d.*	£	*s.*	*d.*
Terra Archiep. Cant. . . .	100	14	0	86	12	0
Terra Episc. Lond. . . .	190	11	10	157	19	6
Eccl. S. Pet. West. . . .	114	0	0	86	16	6
Eccl. Trin. Rouen . . .	25	10	0	20	10	0
Geoff. de Mandeville . .	121	13	0	112	5	0
Ernald de Hesding . . .	56	0	0	24	0	0
Walter de St. Waleri . .	120	0	0	111	0	0
Terr. alior. Tenent . . .	204	0	0	147	8	0
	932	8	10	746	11	0

We shall now say a few words on the uses and consequences of the Survey. By its completion the king acquired an exact knowledge of the possessions of the crown. It afforded him the names of the landholders. It furnished him with the means of ascertaining the military strength of the country; and it pointed out the possibility of increasing the revenue in some cases, and of lessening the demands of the tax-collectors in others. It was moreover a register of appeal for those whose titles to their property might be disputed.

Appeals to the decision of this Survey occur at a very early period. Peter of Blois notices an appeal of the monks of Croyland to it in the reign of Henry I. Others occur in the Abbreviatio Placitorum from the time of John downward. In later reigns the pleadings upon ancient demesne are extremely numerous: and the proof of ancient demesne still rests with the Domesday Survey. Other cases in which its evidence is yet appealed to in our courts of law, are in proving the antiquity of mills, and in setting up prescriptions *in non decimando.* By stat. 9 Edw. II., called Articuli Cleri, it was determined that prohibition should not lie upon demand of tithe for a new mill. The mill, therefore, which is found in Domesday must be presumed older than the 9th Edw. II., and is, of course, discharged, by its evidence, from tithe.

On the discharge of abbey-lands from tithes, as proved by Domesday, it may be proper to state that Pope Paschal II. at an early period, exempted generally all the religious from paying tithes of lands in their own hands. This privilege was afterwards restrained to the four favoured Orders, the Cistercians, the Templars, the Hospitallers, and the Premonstratensians. So it continued till the fourth Council of Lateran in 1215, when the privilege was again restrained to such lands as the abbeys had at that time, and was declared not to extend to any after-purchased lands. And it extends only to lands *dum propriis manibus coluntur.* From the paucity of dates in early documents, the Domesday Survey is very frequently the only evidence which can be adduced that the lands claiming a discharge were vested in the monastery previous to the year expressed in the Lateran Council.

Although in early times, Domesday, precious as it was always deemed, occasionally travelled, like other records, to distant parts, till 1696 it was usually kept with the king's seal, at Westminster, by the side of the Tally Court in the exchequer, under three locks and keys, in the charge of the auditor, the chamberlains, and the deputy-chamberlains of the exchequer. In the last-mentioned year it was deposited among other valuable records in the Chapter-house, where it still remains.

The two most important works for the student of the Domesday Survey are Kelham's 'Domesday Book illustrated,' 8vo, Lond. 1788, and the 'General Introduction' to the survey, reprinted by command of his Majesty under the direction of the commissioners on the Public Records, 2 vols., 8vo, 1833, accompanied by fresh indices. A translation of the whole, under the title of 'Dom-Boc,' was undertaken early in the present century by the Rev. William Bawdwen, vicar of Hooton Pagnell, in Yorkshire, who published Yorkshire, with the counties of Derby, Nottingham, Rutland, and Lincoln, in 4to, Doncaster, 1809, followed by the counties of Middlesex, Hertford, Buckingham, Oxford, and Gloucester, 4to, Doncaster, 1812; but the work went no further. County portions of this record will be found translated in most of our provincial histories; the best are undoubtedly those in Dugdale's Warwickshire, Nichols's Leicestershire, Hutchins's Dorsetshire, Nash's Worcestershire, Bray and Manning's Surrey, Clutterbuck's Hertfordshire, Surtees' Durham, Ormerod's Cheshire, and Baker's Northamptonshire, as far as it was published. Mr. Henry Penruddocke Wyndham published Wiltshire, extracted from Domesday Book, 8vo, Salisb. 1788, and the Rev. Richard Warner, Hampshire, 4to, Lond. 1789. Warwickshire has been published more recently by Mr. Reader. There are numerous other publications incidentally illustrative of Domesday topography, which the reader must seek for according to the county as to which he may desire information.

DOMICILE. In the Roman law *Domicilium.* Many jurists have attempted to define domicile, but they have scarcely succeeded in so doing; the question, whether one domicile has been abandoned and another acquired depends so much upon acts and intention in each particular case, that no general rule will universally apply. A domicile might be described as "a residence at a particular place, with an evident intention to remain there."

The following rules appear to comprise the generally adopted principles on the subject:—

1. The domicile of the parents is the domicile of the child. "*Patris originem unusquisque sequitur.*" ('Cod.' lib. 10, tit. 32 (31), 36.) This is usually called the domicile of origin or nativity, and is in most cases the same with the place of birth. But the mere accident of birth in a place where the parents may happen to be *in itinere,* or on a visit, will have no effect in determining the domicile of origin. An illegitimate child, having no father in contemplation of law, follows the domicile of its mother.

2. Minors are generally considered incapable of changing, by their own act, the domicile of origin during their minority. If the father change his domicile, that of the children follows it; and if he dies, his last domicile will be that of his infant children. It has been much questioned whether the guardians of minors, idiots, or lunatics can change their domicile. It has been held in England that a mother, being guardian, might change the domicile of her children, provided it was not done for a fraudulent purpose, which would be presumed in the absence of any reasonable motive. In Scotland, a minor, after the age of puberty, is not personally under the control of his guardian, and may change his domicile by his own act.

3. A married woman follows the domicile of her husband.

4. A widow retains the domicile of her late husband till she acquires another.

5. The place where a man resides is, for a great many purposes, to be considered his domicile, and, *primâ facie,* is to be taken to be so till other facts establish the contrary.

6. Every person of full age, who removes from one place to another, with the intention of making the latter his place of permanent residence, constitutes it his domicile.

7. The domicile of origin must be considered to prevail till the party has not only acquired another, but manifested and carried into effect an intention of abandoning his former domicile, and adopting another as his sole domicile. But the domicile of origin cannot be preserved by a mere floating intention of returning to it at some future period, or revived by a mere abandonment of the acquired domicile, unless perhaps where the party dies *in itinere* towards the intended domicile. "It is to be remembered," says Sir William Scott (Lord Stowell), "that the native character easily reverts, and that it requires fewer circumstances to constitute domicile in the case of a native subject than to impress the national character on one who is originally of another country."

8. An acquired domicile is not lost by mere abandonment, but continues until a subsequent domicile is acquired, which can be done only *animo et facto.*

9. A married man's domicile is generally taken to be where the residence of his family is; unless this conclusion is controlled by circumstances, such as proof that he has altogether abandoned his family, or that their place of residence is temporary: but

10. If a man, whether married or not, has two places of residence at different times of the year, that will be esteemed his domicile which he himself selects, describes, or deems to be his home, or which appears to be the centre of his affairs; for example, that of a nobleman or country gentleman, his residence in the country—that of a merchant, his residence in town.

11. Residence in a place, to produce a change of domicile, must be voluntary. Thus, if it be produced by constraint, as by banishment, arrest, or imprisonment, it cannot affect the domicile. For the same reason a person abroad in the service of the state does not change his domicile. But it has been held that a Scotchman entering the service of the East India Company acquires a domicile in India, which (like a domicile acquired in any of the colonies) is in legal effect the same as a domicile in England. (Craigie *v.* Lewin, 3 Curt. Eccl. Rep. 447.)

12. It was held in the Roman law that a man might, under certain circumstances, be said to have no domicile, as when he quits one place of residence with the intention of fixing himself in another. But this is not admitted in our law, in which, as before stated, it is held that the former domicile is not lost till the new one is acquired *animo et facto.* And in the possible case of a man of unknown origin acquiring two contemporaneous domiciles under the same circumstances, the *lex loci rei sitæ* would probably prevail *ex necessitate* in questions as to his personal property.

Thus it appears that domicile, considered in relation to the civil status of the person, is of three kinds—1st, domicile of origin, depending on that of the parents at the time of birth; 2nd, domicile of choice, which is voluntarily acquired by the party; and, 3rd, domicile by operation of law, as that of a wife, arising from marriage.

Personal property must be distributed according to the law of the country in which the deceased was domiciled at the time of death. So also, according to our present law, a will is treated as valid or not, as it is or is not executed in conformity with the law of the country in which the testator died domiciled. The validity of a marriage will depend on the law of the country in which it takes place, provided the parties thereto are *bonâ fide* domiciled in that country, but the resort to a foreign country for the purpose of benefiting by the laxity of foreign law in respect of marriage will not avail, unless there be a *bonâ fide* domicile in that foreign country. In England every person, whether native or foreigner, who is for the time being within England, is amenable to the jurisdiction of its civil courts, and may sue or be sued in them. In Scotland, when the subject of dispute is within the jurisdiction of the courts, an action regarding it may proceed there, and any one who has property within their jurisdiction may be made amenable to the extent of that property. But actions of personal status, as for divorce, establishing a marriage, &c., can only proceed when the parties have established a domicile there by residence for forty days.

(On this subject, see Phillimore on *Domicile*, and Story's *Commentaries on the Conflict of Laws*, c. iii.)

DOMINANT, in music, the fifth of the key. Thus, if the key be C, the dominant is G.

DOMINICAL LETTER (*dies domi'nica*, Sunday). To every day in the year is attached one of the first seven letters, A, B, C, D, E, F, G; namely, A to the first of January, B to the second, &c.; A again to the eighth of January, and so on. The consequence is, that all days which have the same letter fall on the same day of the week. The *dominical letter* for any year is the letter on which all the Sundays fall. Thus, the first of January, 1854, being Sunday, the dominical letter for 1854 is A. In a common year, the first and last days have the same letters, whence the dominical letter of the succeeding year is one earlier in the list: that is, the dominical letter for 1855 is G. But in leap-year, it is to be remembered that the 29th of February has no letter attached to it: whence every leap-year has two dominical letters, the first for January and February, the second for all the rest of the year, the second being one earlier than the first. The following will now be easily understood; each year is followed by its dominical letter; 1853, B; 1854, A; 1855, G; 1856, F, E; 1857, D; 1858, C; 1859, B; 1860, A, G.

As it is convenient in historical reading to be able to find the day of the week on which a given day in a distant year fell, we subjoin the following tables. The middle column of figures contains the tens and units of the year in question, while the figures at the head contain the hundreds and tens of hundreds. Thus for the years 536 and 1772, look for 36 and 72 in the middle column, and for 5 and 17 at the head. On the left of the middle column is all that relates to the *old style*; on the right all that relates to the *new style*. The large letters on the left refer to years after Christ, the small letters to years before Christ.

OLD STYLE. The large letters refer to years *after* the Christian Era, and the small letters to years *before* it.											NEW STYLE.			
0 7 14 21 28 35	1 8 15 22 29 36	2 9 16 23 30 37	3 10 17 24 31 38	4 11 18 25 32 39	5 12 19 26 33 40	6 13 20 27 34 41					1 5 9 13 17 21 25 29 33 37	2 6 10 14 18 22 26 30 34 38	3 7 11 15 19 23 27 31 35 39	4 8 12 16 20 24 28 32 36 40
B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	1	29	57	85	B	D	F	G
A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	2	30	58	86	A	C	E	F
G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	3	31	59	87	G	B	D	E
FE*ba*	GF*ag*	AG*gf*	BA*fe*	CB*ed*	DC*dc*	ED*cb*	4	32	60	88	FE	AG	CB	DC
D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	5	33	61	89	D	F	A	B
C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	6	34	62	90	C	E	G	A
B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	7	35	63	91	B	D	F	G
AG*gf*	BA*fe*	CB*ed*	DC*dc*	ED*cb*	FE*ba*	GF*ag*	8	36	64	92	AG	CB	ED	FE
F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	9	37	65	93	F	A	C	D
E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	10	38	66	94	E	G	B	C
D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	11	39	67	95	D	F	A	B
CB*ed*	DC*dc*	ED*cb*	FE*ba*	GF*ag*	AG*gf*	BA*fe*	12	40	68	96	CB	ED	GF	AG
A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	13	41	69	97	A	C	E	F
G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	14	42	70	98	G	B	D	E
F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	15	43	71	99	F	A	C	D
ED*cb*	FE*ba*	GF*ag*	AG*gf*	BA*fe*	CB*ed*	DC*dc*	16	44	72		ED	GF	BA	CB
C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	17	45	73		C	E	G	A
B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	18	46	74		B	D	F	G
A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	G*g*	19	47	75		A	C	E	F
GF*ag*	AG*gf*	BA*fe*	CB*ed*	DC*dc*	ED*cb*	FE*ba*	20	48	76		GF	BA	DC	ED
E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	21	49	77		E	G	B	C
D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	22	50	78		D	F	A	B
C*d*	D*c*	E*b*	F*a*	G*g*	A*f*	B*e*	23	51	79		C	E	G	A
BA*fe*	CB*ed*	DC*dc*	ED*cb*	FE*ba*	GF*ag*	AG*gf*	24	52	80		BA	DC	FE	GF
G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	F*a*	25	53	81		G	B	D	E
F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	E*b*	26	54	82		F	A	C	D
E*b*	F*a*	G*g*	A*f*	B*e*	C*d*	D*c*	27	55	83		E	G	B	C
DC*dc*	ED*cb*	FE*ba*	GF*ag*	AG*gf*	BA*fe*	CB*ed*	28	56	84		DC	FE	AG	BA
DC*dc*	ED*cb*	FE*ba*	GF*ag*	AG*gf*	BA*fe*	CB*ed*	Years ending with 00.				C	E	G	BA

Example 1. What was the dominical letter of the year 763, *before Christ*, old style? Look on the left, opposite to 63, in the column which has 7 among the headings, and the *small letter* there found is *e*. Hence E was the dominical letter of 763 B.C., or the fifth of January was a Sunday.

Example 2. What is the dominical letter of 1819, *after Christ*, old style? Look on the left, opposite to 19, in the column which has 18 among its headings, and the large letter there found is E. Hence E is the dominical letter of 1819 (old style), or the fifth of January was a Sunday.

Example 3. What will be the dominical letters of the year 1896, new style? Look on the right, opposite to 96, in the column which has 18 among the headings, and E D is found. Hence in this leap-year E is the dominical letter for the opening of the year, or the fifth of January will be a Sunday, and after February the dominical letter will be D.

Having found the dominical letter for a given year, the following table will assist in finding the day of the week upon which a given day of the month falls. It is the list of days which have A for their letter.

January	1	8	15	22	29
February	5	12	19	26	..
March	5	12	19	26	..
April	2	9	16	23	30
May	7	14	21	28	..
June	4	11	18	25	..
July	2	9	16	23	30
August	6	13	20	27	..
September	3	10	17	24	31
October	1	8	15	22	29
November	5	12	19	26	..
December	3	10	17	24	31

Thus the dominical letter being E, we ask on what day the 20th of July falls. The E being Sunday, the A is Wednesday, and July 16 is Wednesday, whence July 20 is Sunday.

DOMINICANS. [BLACK FRIARS.]

DONATIO MORTIS CAUSA, a gift made in prospect of death. The doctrine is derived from the civil law, and a donation of this kind is defined in the 'Institutes' (lib. ii. tit. 7) as "a gift which is made under an apprehension of death, as when a thing is given upon condition that, if the donor die, the donee shall have it, or that the thing given shall be returned if the donor shall survive the danger which he apprehends, or shall repent that he has made the gift; or if the donee shall die before the donor." In the English law it is necessary to the validity of this gift that it be made by the donor with relation to his dying by the illness which affects him at the time of the gift, but it takes effect only in case he die of that illness. There must be a delivery of the thing itself to the donee; but in cases where actual transfer is impossible, as, for instance, goods of bulk, deposited in a warehouse, the delivery of the key of the warehouse is effectual. A donatio mortis causâ partakes of the nature of a legacy so far as to be liable to the debts of the donor, and, by 36 Geo. III., c. 52, s. 7, to the legacy duty; but as it takes effect from the delivery, and not by a testamentary act, it is not within the jurisdiction of the ecclesiastical court, and neither probate nor administration is necessary, nor the assent of the executors, as in the case of a legacy.

On the Roman donatio mortis causâ the reader may consult 'Heineccius;' and the 'Digest,' lib. xxxix., tit. 6. As to the Scotch law, see 'Ersk. Instit.' lib. iii., tit. 3, s. 91.

DONATISTS. [Donatus, in Biog. Div.]

DONATIVE. [Benefice.]

DOOMS, FALSING OF, a term of the old Scots law, somewhat similar in import with appeal of false doom, or writ of false judgment in the law of England. A doom or judgment thus falsed or charged with injustice, was of old taken from the bailies of burghs to the court of Four-boroughs, or from the court baron or freeholder's court to the court of the sheriff, and from either to the justice ayre, and thence to the parliament. The proceeding has long been obsolete.

DOOR. The movable panel by means of which the space of a passage or opening in a wall is closed, is technically known as a door (from the Teutonic root *Thor*, or *deur*); and it may be executed of various materials according to the purposes the opening itself is intended to serve. There are bronze, stone, iron, and wooden doors: and an infinite number of varieties of each of those descriptions of material.

Wooden doors are those which are the most commonly used, and therefore they are the ones it would be desirable to notice before the others. They are either framed, or panelled; or they consist of close, or open, boarding, kept together by ledges, or by bracing. Panelled doors are said to be square framed, moulded, bolection moulded, bead flush, or bead butt, according as they may be made to assume either of those forms of framing [Joinery]; and they may present those characters on one or two sides, as the case may be. The simpler boarded doors may either be composed of close, clamped boarding; or they may be ledged doors, with merely the horizontal pieces required to keep the boards in their places, and to receive the hinges; or they may be ledged and braced, with the horizontal ledges, which are kept from warping, or deforming, by means of angular braces. Ledged doors are usually cheaper than framed ones, and therefore are used for commoner descriptions of buildings; whilst the panelled doors, from the fact of their being susceptible of receiving ornamental decoration, are exclusively used in buildings of importance. In many cases the more costly kinds of wood are used for doors, either solidly, or as veneers; and of late years much attention has been paid to their decoration, by means of the application of glass, porcelain, and other costly furniture. [Ironmongery.]

Iron doors are frequently used for the purpose of intercepting the communication of fire, or for closing the entrances of strong rooms or safes; and in such cases they are made to assume the general character of the other doors in the building wherein they are placed. Whatever appearance may be thus given to them, it is essential that they should have a double case; and although cast-iron doors may in some cases present a satisfactory degree of strength and durability, yet, as a general rule, it is preferable to make the doors of strong rooms entirely of wrought iron, especially where there may be any possible danger from fire.

Bronze doors are only used in the decoration of large public or ecclesiastical buildings; and when so employed they are made to receive the highest description of artistic decoration. There are few specimens of this class of work in our own country; but abroad they have been frequently executed, as in the Pantheon of Rome, the celebrated gates of the Baptistery of the Cathedral of Florence, by Ghiberti, or more recently in the doors of the Madelaine, and of the church of St. Vincent de Paul, at Paris.

Stone or marble doors have occasionally been executed in public buildings, and especially in cemeteries; but their great weight must always constitute a serious objection to them. Some of the marble gates and doors of the Belgian churches may especially be referred to as illustrating this species of decoration; and the very remarkable real and false stone doors of the tombs at Aizani (figured in Téxier's 'Asie Mineure'), may be cited as illustrations of the ancient practice in such works.

In describing the various kinds of doors, of whatsoever material they may be composed, it is essential to observe that the following names are applied. Doors may be *real* or *false*; they may be *single*, or *double*; *entire*, or cut into two, or more, *hatches*; and again *single*, or *folding*; or if divided from top to bottom they may be in one or more *leaves*; whilst a small door formed in part of a larger one is called a *wicket*. A *trap* door is one which closes a horizontal opening; a *jib* door is one which closes a vertical opening so as to conceal the latter; a *swing* door is one which, not being stopped by the rebate of the door-frame, is able to pass over more than the quadrant of revolution of ordinary doors; and *rolling*, or *sliding* doors are those which move laterally upon rollers or runners, so as to avoid their development into the rooms they are intended to close.

On many occasions, it may be added, wooden doors were very elaborately carved; as in the case of the doors of St. Maclou, of Rouen, carved by Jean Goujon.

DOORWAY. An opening in the walls or partitions of a building, by means of which access is obtained from one part thereof to another, and which is closed by a door; and it is on this account that a *door* differs from a *window*, which is an opening made for the purpose of receiving light only. A *doorway* differs again from a *gateway* in this respect, namely, that the former is made in a wall, which is under any circumstances carried above it; whilst a gateway is formed in an inclosure, or railing, or fence, which does not exceed the height of the movable panel by which the gateway itself is closed. Habitually the term doorway is specially applied to the openings in houses, or public buildings; that of gateways to those of fence railings.

In doorways the sides, or the *jambs*, and the head or *lintel*, are frequently made the subjects of the most elaborate ornamental decoration, and much of the architectural expression of a building depends on the manner in which this detail is treated. In Greek, Hindoo, Egyptian, and Assyrian architecture, the doorways are almost invariably executed with straight lintels; and from the remains of the tombs of Lycia it would appear that this mode of treating the door openings was founded upon the original practice of the builders in wood, for the trabeated character of those openings is manifestly copied from the ancient log cabins, which must have surrounded the artists who designed those remarkable sepulchres. In the Roman, and the Byzantine, Saracenic, and Gothic styles, however, doorways were frequently, and latterly exclusively, made with arched openings, modified in each case by the spirit of the rest of the design, and by the purpose for which the building was intended, or by the description of door to be used. Thus, a doorway in the inclosure wall of a town would be provided with a portcullis as an additional defence, and therefore would have deep reveals; the doorways of ordinary buildings would simply be modified according to whether the doors were in one or two leaves, or whether they opened inwardly, outwardly, or were hung on rollers.

Constructively the most important considerations with respect to doorways are, firstly, those relating to the power of the jambs, on which the doors are hung, to resist the action of the revolving weight, and the jar arising from the abrupt closing of the door; and, secondly, those relating to the power of the lintel to resist the superincumbent pressure, and to maintain the jambs in their vertical positions. It is in order to secure the latter condition, also, that door *cills*, or transverse stiffening pieces, are introduced at the feet of the jambs. Very frequently the strain is removed from the lintel by means of what is called a discharging arch; and in many cases this contrivance is made to add considerably to the picturesque effect of a doorway, by the application of polychromic materials.

The sizes of doorways are usually made in England from 7 feet 6 inches high by 3 feet 6 inches wide, to 8 feet 6 inches by 4 feet 6 inches for external doors; 7 feet by 3 feet is the usual size for internal doors, and 6 feet 9 inches by 2 feet 10 inches is the minimum size adopted in such cases. The minimum size of folding doors is from 8 feet 6 inches to 9 feet high, by from 5 feet 6 inches to 6 feet wide; these dimensions, however, may be increased to almost any extent to suit the size of the rooms.

The best illustrations of doorways are to be found in the works of Professor Donaldson, 'Doorways from Ancient and Modern Buildings;' Téxier's 'Arménie,' and his 'Asie Mineure.'

DORADO (constellation), the sword-fish, a constellation of Bayer, situated in the southern hemisphere, and cut nearly in half by a line joining α Argûs and α Eridani. The principal stars are as follows:

Character.	No. in Catalogue of Lacaille.	No. in Catalogue of British Association.	Magnitude.
γ	327	1331	4
α	356	1438	3
β	436	1791	4

DORIC ORDER. [Greek Architecture.]

DORSTENIA, a genus of plants of the family of the *Urticaceæ*. The roots of several species of this genus, natives of Mexico, New Spain, and some West Indian islands, are all confounded under the appellation of Contrayerva root, but as they all possess nearly the same chemical composition and properties, it is of little importance which particular species yields what is used. Indeed, by the time the root reaches Europe, whatever virtues it originally possessed are lost, so that it has scarcely any sensible qualities, and very little effect on the system. It consists of volatile oil, extractive, and starch. The first of these gives it some power over the nervous system, should it not have been dissipated by time. Hence it is recommended in the low stages of fever, especially of children; but serpentaria root may at all times be advantageously substituted for it. Contrayerva signifies antidote, and it was at one time supposed to be an antidote to all poisons, whether animal, vegetable, or mineral, except mercury.

Contrayerva is now properly omitted from the 'London Pharmacopœia.' It has no place in the pharmacopœia of the United States, though it may be obtained there much fresher. The root of *Dorstenia Brazilientis* is certainly powerful when fresh, and often acts as an emetic—a property rendering it useful in fevers.

DORT, SYNOD OF, an assembly of Protestant divines convoked at Dort (Dordrecht), in the year 1618, by the States General, under the influence of Prince Maurice of Nassau, by which the tenets of the Arminians, in five points, relating to predestination and grace, were condemned by the followers of Calvinism.

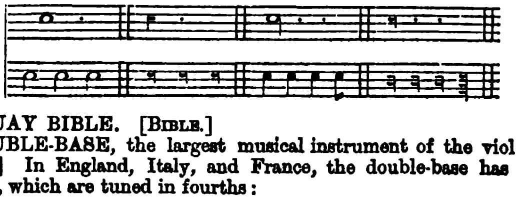
At this synod ecclesiastical deputies were present from most of the States of the United Provinces, and from the churches of England, Hesse, Bremen, Switzerland, and the Palatinate. Those from England were Dr. George Carleton, bishop of Landaff; Dr. John Davenant, regius professor of divinity at Cambridge, and master of Queen's College; Dr. Samuel Ward, master of Sidney College; and Dr. Joseph Hall, then dean of Worcester, but afterwards bishop of Norwich. Dr. Hall's health, after two months, requiring his return, he was replaced by Dr. Thomas Goad. To these was afterwards added Walter Balcanqual, a Scots divine, deputed by King James on behalf of the churches of that nation. The synod was opened on November 13, 1618: it consisted of thirty-eight Dutch and Walloon divines, five professors of universities, and twenty-one lay-elders; the foreign divines amounted to twenty-eight. Those from England had the precedence, after the deputies of the States.

Of the disputes which had prevailed in Holland for some years, between the Calvinists and Arminians, previous to the convocation of this synod, we have already spoken in the Biog. Div., in the notices of Arminius and of Barneveldt, the grand pensionary, whose fate was sealed when it had been sanctioned by the decision of this assembly.

In the sixth session, which was held on the 19th of November, 1618, the synod of Dort proposed obtaining a translation of the Bible from the original texts into Dutch, which was judged to be a necessary work. In the seventh, and some of the succeeding sessions, the translation was finally agreed to, and rules laid down for the direction of the translators. In the thirteenth session, on the 26th of November, the translators were appointed, when the following were chosen by a majority of votes: John Bogerman, the president of the synod; William Baudart and Gerson Bucer, for the Old Testament; Jacobus Roland, Herman Faukelius, and Peter Cornelius, for the New Testament and Apocrypha. The synod then chose sixteen supervisors of the translation; and also resolved, that in case any of the translators should die or be disabled by sickness, the president, with the two assessors, and the scribes of the synod, should be empowered to appoint uccessors.

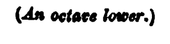
After a delay of nearly ten years, the translators of the Old Testament assembled at Leyden, in 1628, and the next year, 1629, the translators of the New Testament; but as Herman Faukelius, pastor of the church of Middleburg, and Peter Cornelius, pastor of the church of Enchusan, had died previous to their meeting together, Anthony Walæus and Festus Hommius were chosen in their stead. When the translation of the Old Testament had advanced as far as the first chapter of Ezekiel, Gerson Bucer died, and was succeeded in his office by Anthony Thysius; Jacobus Roland also died when the translation of the New Testament had advanced to the Acts of the Apostles. The translation of the entire Bible was completed in 1632. The supervisors of the Old Testament met at Leyden, with the translators, in 1633; and those of the New Testament in 1634: and the revision was completed in October, 1635. The printing of the Bible was finished in 1637, when it appeared in folio from the presses of Leyden and the Hague, and in octavo from the press of Amsterdam. This is what is called 'The Dort Bible.' Editions of it were soon rapidly multiplied and extensively circulated.

DOT, in Music, a point, or speck, placed after a note or rest, in order to make such note or rest half as long again. Thus a semibreve with a dot is equal to three minims: a crotchet rest with a dot is equal to three quaver rests. In modern music a double dot is often used, in which case the second is equal to half of the first. Thus a double dotted minim is equal to three crotchets and a quaver; a double-dotted quaver rest is equal to three semiquaver rests and one demisemiquaver rest. Examples:—



DOUAY BIBLE. [Bible.]

DOUBLE-BASE, the largest musical instrument of the viol kind. [Viol.] In England, Italy, and France, the double-base has three strings, which are tuned in fourths:



(*An octave lower.*)

In Germany a fourth string is used, tuned a fourth below the deepest of the above.

The double-base, in full orchestral pieces, takes the notes written for the violoncello, when not otherwise directed, and if these are not too rapid, but always gives them an octave lower. It may be considered as the foundation of the band, for a want of firmness in this instrument is more fatal in its consequences than unsteadiness in any other.

In our concerts the Italian name of this instrument, *Contra-basso* (or, more strictly, *Contrab-basso*), is as frequently employed as its English appellation.

DOUBLE STARS. [Stars, Double.]

DOUBLETS. In optical instruments where high powers are required there is much practical inconvenience in forming single lenses of short focal length. The difficulty has been obviated by the use of magnifiers formed of two or more lenses combined. The most efficient are two or three plano-convex lenses, with their convex sides towards the eye, and are hence called *doublets* or *triplets*.

DOUBLOON. [Money.]

DOUCHE. [Bathing.]

DOVETAIL, a term in construction. A dovetail is the end of a piece of wood or metal fashioned into the fan-like form of a dove's tail, and let into a corresponding hollow of another piece of wood, stone, or metal. Dovetails are either exposed or concealed; "concealed dovetailing is of two kinds, lapped and mitred." Dovetailed metal cramps are much used in masonry.

DOWER (Law) is that part of the husband's lands, tenements, or hereditaments which come to the wife upon his death, not by force of any contract expressed or implied between the parties, but by operation of law, to be completed by an actual assignment of particular portions of the property.

Prior to the reign of Charles II., five, and until the passing of the Act 3 & 4 Will. IV., c. 105, four kinds of dower were known to the English law.

1. Dower at the common law.
2. Dower by custom.
3. Dower ad ostium ecclesiæ.
4. Dower ex assensu patris.
5. Dower de la plus beale.

This last was merely a consequence of tenure by knight's service, and was abolished by stat. 12 Charles II. c. 24; and the 3rd and 4th, having long become obsolete, were finally abolished by the above-mentioned statute.

By the old law, dower attached upon the lands of which the husband was seised at any time during the marriage, and which a child of the husband and wife might by possibility inherit; and they remained liable to dower in the hands of a purchaser, though various ingenious modes of conveyance were contrived, which in some cases prevented the attaching of dower; but this liability was productive of great inconvenience, and frequently of injustice. The law too was inconsistent, for the wife was not dowable out of her husband's equitable estates, although the husband had his courtesy in those to which the wife was equitably entitled. [Courtesy.] To remedy these inconveniences the statute above mentioned was passed, and its objects may be stated to be: 1, to make equitable estates in possession liable to dower; 2, to take away the right to dower out of lands disposed of by the husband absolutely in his life or by will; 3, to enable the husband, by a simple declaration in a deed or will, to bar the right to dower. This could always have been done by levying a fine, an expensive and inconvenient remedy: while the increase of personal property, and the almost universal custom of securing a provision by settlement, afforded effectual and convenient means of providing for a wife.

Dower at the common law is the only species of dower which affects lands in England generally; dower by custom is only of local application, as dower by the custom of gavelkind and Borough English; and freebench applies exclusively to copyhold lands.

In order to describe dower at the common law clearly, it will be advisable to follow the distribution of the subject made by Blackstone.

1. Who may be endowed.
2. Of what a wife may be endowed.
3. How she shall be endowed.
4. How dower may be barred or prevented.

1. *Who may be endowed.*—Every woman who has attained the age of nine years is entitled to dower by common law, except aliens, and formerly Jewesses, so long as they continued in their religion. From the disability arising from alienage, a queen, and also an alien licensed by the sovereign, are exempt.

2. *Of what a wife may be endowed.*—She is now by law entitled to be endowed, that is, to have an estate for life in the third part of the lands and tenements of which the husband was solely seised either in deed or in law, or in which he had a right of entry, at any time during the coverture, of a legal or equitable estate of inheritance in possession, to which the issue of the husband and wife (if any) might by possibility inherit.

3. *How she shall be endowed.*—By Magna Charta it is provided, that the widow shall not pay a fine to the lord for her dower, and that she

shall remain in the chief house of her husband for forty days after his death, during which time her dower shall be assigned. The particular lands and hereditaments to be held in dower must be assigned by the heir of the husband, or his guardian, by metes and bounds if divisible, otherwise specially, as of the third presentation to a benefice, &c. If the heir or his guardian do not assign, or assign unfairly, the widow has her remedy at law, and the sheriff is appointed to assign her dower; or by bill in equity, which has long been the usual remedy.

4. *How dower may be barred or prevented.*—A woman is barred of her dower by the attainder of her husband for treason, by her own attainder for treason, or felony, by divorce *à vinculo matrimonii*, by elopement from her husband and living with her adulterer, by detaining the title-deeds from the heir at law, until she restores them, by alienation of the lands assigned her for a greater estate than she has in them; and she might also be barred of her dower by levying a fine, or suffering a recovery during her marriage, while those assurances existed. But the most usual means of barring dower are by jointures, made under the provisions of the 27 Hen. VIII., c. 10; and by the act of the husband. Before the stat. of Will. IV., a fine or recovery by the husband and wife was the only mode by which a right to dower which had *already attached* could be barred, though, by means of a simple form of conveyance, a husband might prevent the right to dower from arising at all upon lands purchased by him. By the above-mentioned statute, it is provided that no woman shall be entitled to dower out of any lands absolutely disposed of by her husband either in his life or by will, and that his debts and engagements shall be valid and effectual as against the right of the widow to dower. And further, that any declaration by the husband, either by deed or will, that the dower of his wife shall be subjected to any restrictions, or that she shall not have any dower, shall be effectual. It is also provided that a simple devise of real estate to the wife by the husband shall, unless a contrary intention be expressed, operate in bar of her dower. As to the law of dower in the United States of America, see vol. iv. Kent's 'Commentaries.'

DOWNS. [DUNES.]

DOXOLOGY, a form of giving glory to God, from the Latin *doxologia*, and that from the Greek *doxa* (δόξα), glory, and *logos* (λόγος), a word or saying. The doxology in the concluding paragraph of the Lord's Prayer, "Thine is the kingdom, and the power, and the glory," is left out of many of the ancient copies of St. Matthew's Gospel, though it appears in others; St. Luke omits it entirely. The authenticity of this form of praise, as a paragraph of the prayer, has been a difficult subject of dispute. It does not appear in the Vulgate, but it seems to be established by the Greek MSS. and the Eastern versions. Doxology is also used for the verse used in the Common Prayer, from Luke ii. 14, "Glory to God in the highest, and on earth peace, good will to all men;" and for the short hymn, *Gloria Patri*, which we use in our church service at the end of every psalm, and of every hymn except *Te Deum*, which is a doxology of itself. Durand and other writers consider this exception to have been introduced into the Romish church by St. Jerome. The first express mention of it is in the second council of Vaison, A.D. 529. Amongst the early Christians it was always considered as a solemn profession of their belief in the Trinity.

DRACHM. [DRAM.]

DRACHMA, from the Greek *drachme* (δράχμη), a silver coin, the unit of the Greek coinage. The value of the drachma varied in the different provinces of Greece: though it was the chief coin in use among the Greeks. A talent contained 10,000 drachmæ reckoned by weight, but a talent of gold was worth 120,000 silver drachmæ. The didrachm or two drachms, the tridrachm or three drachms, and the tetradrachm or four drachms, were its multiples. The last was the largest form of Greek silver. The average weight of five drachmæ in the British Museum is 60·92 grains; and the average weight of three tetradrachmæ in the British Museum is 260·56 grains. The Attic drachma has been supposed to have been the same among the Greeks with the denarius among the Romans: others have disputed this; but both may be reconciled by the consideration that the number of drachmæ, as well as of denarii, which went to the ounce, might have been subject to occasional variations.

Drachma.

British Museum. Actual size. Silver. Weight, 61$\frac{5}{10}$ grains.

DRACINA, the name given by Melandri to the colouring-matter of dragon's blood, and which he supposed to be a vegetable alkaloid; but Berzelius and Herberger are of opinion that it does not possess alkaline properties: the last-mentioned chemist, indeed, calls this colouring-matter *draconin*, and he considers it to possess rather sub-acid properties than such as denote alkalinity.

DRACO (the dragon), one of the old constellations, referred by Hyginus to the fable of the Hesperides. It is constantly stated by the older writers as being placed between Ursa Major and Ursa Minor, which hardly suits the present position of the constellation, since its principal stars are all contained between Ursa Minor, Cepheus, Cygnus, and Hercules. The two stars in the head (β and γ, the latter celebrated as passing very near the zenith of the south of England, and as being the one used in the discovery of aberration [BRADLEY, BIOG. DIV.]) are nearly in the line joining α Cygni (Deneb) and Arcturus; while seven or eight smaller stars wind round Ursa Minor in such a manner as to render the name of the constellation not unappropriate. The extreme star (λ) is very nearly between the pole star and its pointers. [URSA MAJOR.] The principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
λ	1	3914	3·5
κ	5	4239	3·5
α	11	4696	3·5
ι	12	5097	3
θ	13	5348	3
η	14	5512	3
A	15	5545	4
μ′	21	5785	4
ζ	22	5823	3
β	23	5937	2·5
ω	28	6006	4
ξ	32	6079	3·5
γ	33	6091	2
χ	44	6302	4·
δ	57	6612	3
π	58	6662	4
τ	60	6650	4·5
σ	61	6735	4

DRACONIC ACID. [ANISIC ACID.]

DRACONIN, the *dracina* above mentioned, may be obtained, according to Melandri, by macerating dragon's blood in water acidulated with sulphuric acid: this becomes of a yellow colour, but does not act upon the draconin, which is of a fine red colour, and very fusible; it may be worked between the fingers, and drawn into threads. It melts at about 130°; on solidifying it becomes of a crimson colour, and when triturated gives a cinnabar red colour. It dissolves readily in alcohol, and the solution, which is of a fine red, becomes yellow on the addition of an acid; but on the addition of an alkali the red colour is restored. It does not appear to have been analysed.

DRACONYL. [STYROL.]

DRACYL. [TOLUINE.]

DRAGOMANS, or DROGOMANS (from the Turkish *Trukĕman*); the term by which the interpreters attached to the European consulates and embassies in the Levant are known. At Constantinople they are the chief, and in most cases the sole medium of communication between Christian ambassadors, who are ignorant of the Turkish language, and the Ottoman Porte; several are attached to every embassy, and the consuls in the Turkish dominions generally have one. They are men born in the country, and are chiefly descended from old Genoese or Venetian settlers. Their local interests and sympathies have often interfered with their duties; and though there have been honourable exceptions, they are not distinguished as a body for honour and integrity. Austria and France, however, have the privilege of appointing one of their own subjects to the office. The French, as early as the time of Louis XIV., instituted a small body of young men, technically called *Jeunes de langue*, who were sent to the country to learn the language and acquaint themselves with its laws and customs; and Austria maintains an Oriental academy at Constantinople, to enable young men to qualify themselves. The dragomans and their families enjoy the protection of the nations whom they serve, and are exempted from Turkish law.

DRAGON'S BLOOD, the produce of various species of Calamus, is sent to Europe in several forms. 1. Dragon's blood in tears (sanguis D. in lachrymis); 2. Dragon's blood in grains (S. D. in granis); 3. Dragon's blood in reeds (S. D. in baculis), in rods about 1 to 1½ feet long, about the thickness of the finger, covered with the fronds of the palm, wrapped round it with split branches. This is the best kind now met with in European commerce.

Many other kinds of dragon's blood are procured from different trees in various parts of the world, of which two only are worthy of notice: 1. Dragon's blood in masses, obtained both in the East Indies and Madeira by wounding the stem of the *Dracæna Draco* (Linn.), occurs in large shapeless masses of a violet colour. 2. S. D. de Carthagena, American or West Indian dragon's blood, obtained from the *Pterocarpus Draco* (Linn.). It occurs in pieces about 12 or 14 inches long, with a sharp angle on one side, partly wrapped up in the tendrils of a cissus and in leaves. Dragon's blood is a peculiar resinous colouring principle (*Draconia*), mixed with benzoic acid and other matters. It is insoluble in water, but easily soluble in alcohol, especially when boiling; it is also soluble in watery solutions of the caustic alkalies, and forms with them a violet-coloured solution; it is less soluble in ethers and oils, but soluble in acetic acid. Sulphuric acid chars it. Analysed by Herberger, 100 parts yielded—

Fatty matter	2·00
Oxalate of lime	1·60
Phosphate of lime	3·70
Benzoic acid	3·00
Draconia	70·70

According to Herberger, draconin is not an alkaloid, as Melandri thought, but a sub-acid. ('Journ. de Pharm.,' xvii. p. 225.)

Dragon's blood possesses no astringent properties, as was once supposed to be the case, owing to kino being confounded with it. It is now seldom used internally, but it is added to tooth-powders. It is however employed as a colouring matter and an ingredient in varnishes.

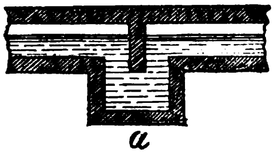
A spurious dragon's blood is often made with colophony, olibanum, turpentine, &c., coloured red with powdered Saunder's-wood. Gum Senegal is also dyed red with tincture of Saunder's-wood and passed for dragon's blood. The spurious is wrapped in the leaves of the Zea Mais, or Indian corn.

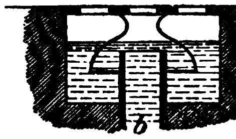
Dragon's blood was known to the Greeks, and by them called *κιννάβαρις*, *cinnabar*, a name which they also gave, as we now do, to a mineral, the red bisulphuret of mercury or *minium*.

DRAGOON. [CAVALRY.]

DRAIN. An artificial channel formed in the ground for the purpose of removing the surplus waters, whether they be supplied from the atmosphere or from land springs. These drains may be formed either of loose stones, of pipes of ordinary brick earth or of stoneware, or of masonry or brickwork, according to the nature and quantity of the water to be removed, or to local conditions of economy. Drains are classified under the names of sub-drains, main-drains, and outfall-drains, according to the functions they may discharge in a system.

DRAIN-TRAP. A pit formed at the entrance to a drain, for the purpose of preventing the escape of the mephitic gases which are frequently given off from the waters collected by a system of drainage; and also of preventing, as much as possible, the introduction of sand, drift, or other encumbering materials, into the subterranean channels. The pit contains, usually, a species of hydraulic seal, which constitutes, in fact, the trap, formed by means of a tongue descending below the surface of the water, as in sketch *a*, when the trap is placed in the course of the drain; or by a solid bell-covering, the lip of which dips into the water in the ordinary bell traps, such as are used in London houses for sinks, drains, rain-water-pipes, &c. A siphon bend in the course of a drain-pipe will constitute an efficient drain-trap, so far as the prevention of smell only is concerned; but it is exposed to the serious objection of being likely to become choked, if the waters should transport much suspended matter.


a


b

DRAINAGE. The removal from the ground of any waters whose sojourn might be pernicious, from whatever source they may be supplied, and the provision of an adequate discharge for those waters, constitute the art of drainage, which has at all times engaged the most serious attention of the hydraulic engineer. The Egyptians and the Assyrians at a very early period executed some curious drainage works, the remains of which still survive; and the Etruscan predecessors of the Roman civilisation practised the art with great success, as certainly was proved by the extraordinary operations effected under the reign of Tarquinius Priscus for the drainage of the low lands at the feet of the seven hills. The Romans themselves devoted a great deal of attention to this subject; and there are in the treatises of Columella, Varro, Cato, on agriculture, and in the books of Vitruvius and Pliny, many remarkable passages illustrating the practice of the Romans in this branch of applied sciences. In the middle ages the art of drainage seems to have been lost sight of; and it was not until about the end of the 16th century that any great works of this description were undertaken. At that period, the Dutch engineers commenced the works for draining the lakes of the province of North Holland, which now constitute the fertile polders of the Purmer, Beemster, Woermer, &c.; and subsequently the great operation of draining the Bedford Level was commenced under the guidance of Sir Cornelius Vermuyden. All these works however were superficial, so to speak, and they were only executed in low-lying, swampy districts; but about the end of the last century Elkington turned his attention to the removal of the injurious waters of upland districts, and the art of drainage rapidly assumed, in consequence of his success, the peculiar character which it now bears. Messrs. Smith of Deanstone, Parkes, and Bailey Denton, have perhaps been the persons who have contributed the most to its advancement.

From this brief sketch of the history of drainage, it will be seen that it may be divided into two great branches, namely, the drainage by means of open cuts, or the drainage by means of subterranean channels; and again, of late years, a distinction has been made between rural and urban drainage, because the latter has been made to comprehend the removal of household refuse in the form usually known as sewerage.

Drainage by open cuts of course can only be applicable when the waters to be removed do not attain a level superior to that of the ground, and when there is an efficient outfall, either natural or artificial; and its success depends upon the maintenance of a regular permanent discharge of the waters supplied by the collecting drains. The surface of the water in these collecting drains must always be kept at such a distance from the surface as to prevent any injurious action upon the vegetation of the land, for it is to be observed that drainage by open cuts is almost exclusively reserved for agricultural districts. In the outfall drains, the water must not be allowed to stagnate, and the cuts must be formed of such dimensions, and in such directions, as to ensure the discharge in the smallest possible time. The rules for calculating the areas and the inclinations of these drains will be found under HYDRAULICS.

In such cases as those of the polders of Holland, and of the fen districts of the east of England, where the natural surface of the land is beneath the mean water level of the surrounding country, it was found necessary to isolate the land about to be drained, and to create an artificial outfall into which the waters were raised, by artificial means, to a level which would allow of their subsequent discharge. The Dutch engineers call these out-falls when they surround a previously submerged district, "ring dykes;" and generally speaking, they raise the drainage waters into them by means of Archimedian screws, or of dash wheels, worked by windmills of a very rude and primitive construction. In the drainage of the Haarlem lake, however, steam power was resorted to, and the water from the submain drains is led, through large cuts, to the pumps of some immense Cornish engines of about 400-horse power each, to be raised by them into the ring dyke, whose dimensions are not less than 125 feet in width by 10 feet deep on the average. The outfall of the ring dyke of the Haarlem lake is into the Spaarn, a river falling ultimately into the Zuyder Zee; and as the Spaarn is itself frequently closed by high tides or by storms, an elaborate system of stop gates, and some large steam-pumping engines, working a set of dash-wheels, is provided to ensure the discharge of the land waters during those periods. Very nearly the same principles have been adopted in designing the works lately executed in the fen districts of Cambridgeshire and Lincolnshire; but in these countries it often happens that the formation of a large intercepting drain (for the purpose of carrying off at once the upland waters, without their being allowed to pass into the drainage cuts of the lower level), will considerably diminish the duty required of the outfall drain. Local conditions must always affect these matters of detail; but the principle—the removal of the largest possible quantity of water by gravitation, instead of by artificial means—is of universal application.

The drainage of bogs, or swamps, in mountainous districts, may very often give rise to the application of other laws; as for instance, when the water, which maintains the permanent state of humidity it is desired to remedy, is supplied by springs rising under considerable pressure; or when the swampiness of the locality arises from the mere accumulation of water at the wet seasons of the year. The Bog of Allen was an instance of the former condition, and in that case the water was relieved by forming a series of artificial channels, or vertical pipes, through which it rose, and poured into a new outfall drain. The Chat Moss, however, was drained simply by means of open cuts, so traced as to carry off the surface waters as rapidly as they fell, and by a trifling improvement in the outfall. The latter operation is, moreover, the principal one required to obviate the supposed inconvenience from the occasional accumulation of rain waters; and it may be stated that there are many thousand acres of the best land in Europe, now unproductive, which might be easily brought into cultivation by the execution of some unimportant works to lower the level of the natural water courses of the districts in which these now valueless tracts are situated. In the north of Spain, in Switzerland, and in the island of Sardinia, there are numerous tracts which only require to be thus treated.

The works necessary for the drainage of a large morass, or fenny district, are usually of such a nature as to require the intervention of the legislature, or of the state; because they involve in many instances serious interference with private rights, and great changes in the hydrographical arrangements of the whole water shed with which they are connected. Perhaps Wells' history of the 'Bedford Level' may furnish some of the most valuable information upon this branch of the subject; or the series of Acts which govern the proceedings of the Commissioners of the Fen districts of Cambridgeshire, namely, 29 Geo. II., c. 22; 39 & 40 Geo. III., c. 26; 50 Geo. III., c. 194; or those lately passed for the regulation of the various Lands Drainage and Improvement Companies, may be referred to as illustrating the principles of legislation recently adopted in England in these matters. The reports by de Prony on the amelioration of the 'Pontine Marshes;' by Tartini, on the 'Maremme Toscane;' and by Fossombroni, on the 'Val di Chiana,' may be cited as illustrations of the scientific principles to be applied in designing the necessary works. Dugdale's 'History of Embankment and Draining,' may also be advantageously consulted, as may also the communications to parliament, by the Commissioners appointed to 'Report upon the nature and extent of the Irish bogs.'

A system of drainage exclusively by open cuts is, at the present day, so rare in our own country, and in fact in all countries, where there is the ordinary variety of hill and dale, that the meaning of the generic term, *drainage*, has almost been perverted to that of a subterranean drainage. There are, however, very essential differences between the conditions which are adapted to these respective modes of operation, and it is dangerous therefore to admit any confusion in the names by which they are characterised. One of the most important of these differences arises from the fact that in open drainage little reference need be made to the daily rain-fall, provided the outfall be established under such conditions as to prevent any serious accumulation of water, whilst the rain-fall of the particular district will regulate the dimensions to be given to a series of subterranean drains, in connection with the usual considerations with respect to the permeability of the strata. It usually happens also that little reference need be made to the permeability of the low lands, to which alone the open cut drainage can be economically applied; because the level of the water in the cuts is usually maintained at a permanent line, and it is only the excess of water which is removed. In fact, in the districts wherein drainage is effected by open cuts, the class of cultivation is usually such as to require the presence of a definite quantity of water in the subsoil, and, in the polders of Holland especially, very serious evil results from an abnormal lowering of the water line. In districts wherein subterranean drains are used, however, it is essential to remove as rapidly as possible any waters which might have a tendency to stagnate around the roots of the plants, or to prevent the surface of the ground from being cooled by the rising of springs. The practical details of the two systems of drainage are naturally much affected by these peculiar local conditions, and in the case of the subterranean drainage the physical outlines of the country will further affect the question, by reason of the greater or less facilities they offer for the throwing off, or retaining surface waters.

In properly drained land, situated at such levels as to allow the water collected in the outfall drains to flow freely, the surface of the ground is always dressed into such tables, or ridges, as to ensure the discharge of the water falling from the atmosphere which does not permeate the surface itself; and the drains have only to carry off the water which soaks through the ground. Evidently, under such circumstances, the drains must be placed at distances varying according to the degree of permeability of the ground, and also of the nature of the subsoil, though the latter condition would rather affect the depth of the drains than their lateral distances. Some discussion has taken place amongst the leading professors of the art with respect to these details; but they seem to have simply fallen into the error of all absolute theoreticians, for it must evidently be absurd to apply indiscriminately any system of either deep or shallow drains; and it must as evidently be the proper course to modify both the depth and the distance apart of the drains, according to local circumstances.

The only invariable condition affecting the depth of drains is, that they must be beyond the reach of any agricultural operations. In light lands the plough often does not descend more than 8 inches, and even in the most fertile districts of the North of Spain not more than 4 inches; whilst in heavy stiff clays, as in the island of Jersey, the depth of the plough is not less than from 18 to 20 inches. It is therefore customary to place the drains, even in what is called shallow drainage, at a minimum depth of from 20 to 24 inches, measuring from the top of the material constituting the channel to the surface of the ground. The maximum depth at which drains are laid does not exceed under any circumstances from 6 to 8 feet, and it is only occasionally that the depth is made more than 4 feet 6 inches from the surface. In shallow drainage the number of the drains is increased, and they are brought closely together; whilst in deeper drainage the distance is augmented. Smith of Deanstone, who was an advocate for shallow drains, usually made them from 6 to 8 yards apart, and about 3 feet deep. Parkes recommends, on the contrary, that the distances asunder should be made from 13 to 20 yards, and that the depth should be made from 4 feet 6 inches to 8 feet. The choice of the respective systems must, however, be regulated by the nature of the subsoil as much as by that of the soil itself, and very careful observations should be made before either of them is adopted.

The width of the trenches will be regulated by the depth of the drain rather than by any other condition, for it must be made wide enough to allow the workmen to perform easily any of the operations required for levelling the bottom of the excavation, or for placing the pipes or other materials. In practice it is found that, for a depth of 3 feet, it is sufficient to give a width of 1 foot at the surface and 3 feet at the bottom; for a depth of about 4 feet, these widths become respectively 1 foot 4 inches and 8 inches; whilst for a depth of 8 feet they become respectively 2 feet 6 inches and 1 foot 2 inches, even in hard resisting grounds, which are not likely to cave in, as the workmen say. The width of the bottom of the trench, it is to be observed, is regulated rather by the necessity for its being sufficiently wide to enable the workmen to lay the pipes than by any other condition; and it is also found, practically, that it is not possible to secure the regularity of the inclination of the bottom, unless the men can stand directly upon it. The success of a system of drainage depends greatly upon the last-named condition,—namely, the regularity of the inclination, as also upon its being made such as to ensure the constant flow of the water. Generally speaking, a fall of 1 in 200, in the minor drains, will suffice, especially when the drain-tiles have been well and carefully laid.

It is not desirable to make the sub-drains of any great length if their inclination should be considerable; because, under such circumstances, it is possible that the head of water in the pipes or channels might burst them, and there is always danger of an accumulation of silt. Generally speaking, the smaller drains do not exceed 100 yards in length before discharging into submains of larger dimensions; and the latter are limited to a length of about 300 yards before discharging into open ditches, or into the main outfall of the district. If it were possible, it would even be preferable to make the small pipes or channels themselves discharge into the open ditches, without using any sub-mains. An important remark to be made with regard to every description of subterranean channel is, that they must be carried as far as possible from trees or hedges; because the roots of the latter have a remarkable avidity for water, and they are sure to find their way into any channel in their immediate neighbourhood. The sub-mains should be laid a little below the ordinary line of the smaller channels, in order to communicate to the water a greater velocity when it approaches the point of junction; and the junctions should be made with a curve upon the plan, so as to avoid any direct interference with the lines of flow of the respective streams.

There are several modes employed for the purpose of filling in the trenches of drains, the choice of which must be regulated by local conditions of economy; though, as a general rule, it would unquestionably be better to resort to the use of pipes of stone or of earthenware. The cheapest, but also the least permanent, mode of forming the channel consists in cutting a species of shoulder near the bottom of the trench, upon which a thick sod of the grass from the surface is laid, with the grass downwards, and then filling in the remainder of the trench with light permeable earth. In countries where stones are easily obtained, it is customary to use them for the purpose of forming the channel; and this is effected by placing two slabs in an inclined position to one another, and covering them to a certain height with the smaller broken stones. Both the stone and the turf channels are, however, liable to become silted up, or even to be choked, by the precipitation of the salts which the waters may hold in solution; and it is on these accounts that agricultural engineers have, of late, given very decided preference to the use of tile or pipe drains. Formerly the tile and shoe drains were the most generally used; and, in filling them in, it was customary to lay flat tiles or shoes at the bottom of the trench, which shoes were made about 14 inches long and about 5 inches wide, and upon them to place the tiles, of the same length, and from 3 to 4 inches wide and 4 or 5 inches high. Of late years cylindrical tubes have been almost exclusively used, not only on account of the economy of their manufacture, but also of the greater ease and regularity with which they can be laid. These pipes are made of almost any diameter, from 1 foot to 1 inch, and of lengths varying from 14 inches in the smaller dimensions to 2 feet in the larger ones; the 2 inch pipes being generally used for the small drains, and the 4 or 6 inch pipes for sub-mains under normal conditions. When cylindrical pipes are used in peaty or very moveable soils, it is necessary to protect the abutting joints by means of collars; but in ordinary soils no such precautions are required to be observed. Drain-pipes of ordinary brick or tile earth are made in almost every county in England by a very simple species of machinery, and they are burnt in close kilns, the prices in the maker's yard being usually about as follows:—For pipes,

1 in. diam.,	the price is 4*s.* 6*d.*	per 1000,	and a cart with 4 horses can carry	8000
1¼	„ 6 0	„	„	7000
1¾	„ 8 0	„	„	5000
2¼	„ 10 0	„	„	3500
2¾	„ 12 0	„	„	3000

In the most economically constructed tile factories, indeed, it appears that the outlay upon plant is so small, that almost any large landed proprietor would have a direct interest in making tiles on his own account. The total expense of a Scragg's pipe-making machine, a pug-mill, drying-shed, and kiln to hold 40,000 tiles, would, according to Captain Johnston, not exceed 220*l.*

It may be here added, that the ordinary cost of pipe-drainage in clay land will vary, according to its more or less permeable nature, between 2*l.* 10*s.* to 5*l.* per acre: in rocky ground, of course the cost would be increased, but fortunately drainage is rarely required in such positions.

In town drainage it is important to observe that the system to be adopted will depend upon the consideration as to whether or not the surface or rain waters are to be carried off simultaneously with those furnished by the houses to which all modern improvements are applied. Drainage in itself is indeed distinct from sewerage; and the materials which are adapted for the one operation may be very inappropriate to the other—a fact which unfortunately has been overlooked by the official authorities who have lately assumed to teach local boards how they ought to execute sanitary works. For many reasons it will be preferable to defer the consideration of this subject to the article SEWERAGE; but it may be necessary here to observe that, especially in cases where a town may be situated upon the outcrop of a permeable stratum likely to feed any surface springs or watercourses, as Croydon or Ipswich, for instance, very serious evil would be produced by neglecting to provide as energetically for the removal of rain or of subterranean waters, as by neglecting to remove the house refuse. The impermeable stoneware drains, which it is now the fashion to recommend indiscriminately, are, in fact, very often a source of great mischief, unless they are accompanied by a series of permeable subsoil drains. The latter must be made of sufficient dimensions to carry off at once the maximum quantity of rain which may run off from the drainage area, and those dimensions must therefore be materially affected by the nature of the surface of the said area, or, in other words, by the consideration as to whether it be or be not built upon, or whether it be paved or merely ordinary ground; the relief of the surface will also materially influence the rapidity with which the rain-flow of a town will find its way into the drains. Generally speaking it is found, moreover, that the subsoil waters which find their way into town drains are exposed to such extraordinary chemical re-actions, that they are as little fitted to be poured into the superficial watercourses as even the waters of sewers.

DRAINING. As a certain quantity of moisture is essential to vegetation, so an excess of it is highly detrimental. In the removal of this excess consists the art of draining. The same, or nearly the same truth, may perhaps be better expressed thus: As water stagnant in the soil is prejudicial to the growth of all our cultivated plants, fertility is greatly promoted by the art of draining, which induces its circulation through the soil.

Water may render land unproductive by covering it entirely or partially, forming lakes or bogs; or there may be an excess of moisture diffused through the soil and stagnating in it, by which the fibres of the roots of all plants which are not aquatic are injured, if not destroyed.

From these different causes of infertility arise three different branches of the art of draining, which require to be separately noticed.

1. To drain land which is flooded or rendered marshy by water coming over it from a higher level, and having no adequate outlet below.

2. To drain land where springs rise to the surface, and where there are no natural channels for the water to run off.

3. To drain land which is wet from its impervious nature.

The first branch includes all those extensive operations where large tracts of land are reclaimed by means of embankments, canals, sluices, and mills to raise the water; or where deep cuts or tunnels are made through hills which formed a natural dam or barrier to the water. Such works are generally undertaken by associations under the sanction of the government, or by the government itself; few individuals being possessed of sufficient capital, or having the power to oblige all whose interests are affected by the draining of the land, to give their consent and afford assistance. In the British dominions there is no difficulty in obtaining the sanction of the legislature to any undertaking which appears likely to be of public benefit. In every session of parliament Acts are passed giving certain powers and privileges to companies or individuals, in order to enable them to put into execution extensive plans of draining. That extensive draining in the counties of Northampton, Huntingdon, Cambridge, Lincoln, Norfolk, and Suffolk, which is known by the name of the BEDFORD LEVEL [GEOG. DIV.], was confided to the management of a chartered corporation, with considerable powers, as early as the middle of the 17th century, and by this means an immense extent of land has been rendered highly productive, which before was nothing but one continued marsh or fen.

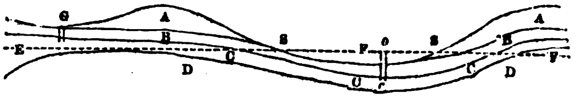
In the valleys of the Jura, in the canton of Neufchâtel in Switzerland, which are noted for their industry and prosperity, extensive lakes and marshes have been completely laid dry, by making a tunnel through the solid rock, and forming an outlet for the waters. All these operations require the science and experience of civil engineers, and cannot be undertaken without great means. The greater part of the lowlands in the Netherlands, and especially in Holland, have been reclaimed from the sea, or the rivers which flowed over them, by embanking and draining, and are only kept from floods by a constant attention to the works originally erected.

Where the land is below the level of the sea at high water, it requires a constant removal of the water which percolates through the banks or accumulates by rains; and this can only be effected by sluices and mills, as is the case in the fens in England. The water is collected in numerous ditches and canals, and led to the points where it can most conveniently be discharged over the banks. The mills commonly erected for this purpose are driven by steam-power, and are true water-wheels, lifting by their float-boards enormous quantities at every revolution from the lower to the higher level.

In hilly countries it sometimes happens that the waters which run down the slopes of the hills collect in the bottoms where there is no outlet, and where the soil is impervious. In that case it may sometimes be laid dry by cutting a sufficient channel all round, to intercept the waters as they flow down and to carry them over or through the lowest part of the surrounding barrier. We shall see that this principle may be applied with great advantage in many cases where the water could not be drained out of considerable hollows if it were allowed to run into them.

When there are different levels at which the water is pent up, the draining should always be begun at the highest; because it may happen that when this is laid dry, the lower may not have a great excess of water. At all events, if the water is to be raised by mechanical power, there is a saving in raising it from the highest level, instead of letting it run down to a lower from which it has to be raised so much higher.

The draining of land which is rendered wet by springs arising from under the soil is a branch of more general application. The principles on which the operations are carried on apply as well to a small field as to the greatest extent of land. The object is to find the readiest channels by which the superfluous water may be carried off; and for this purpose an accurate knowledge of the strata through which the springs rise is indispensable. It would be useless labour merely to let the water run into drains after it has sprung through the soil and appears at the surface, as ignorant men frequently attempt to do, and thus carry it off after it has already soaked the soil. But the origin of the springs must, if possible, be detected; and one single drain or ditch judiciously disposed may lay a great extent of land dry if it cuts off the springs before they run into the soil. Abundant springs which flow continually generally proceed from the outbreaking of some porous stratum in which the waters were confined, or through natural crevices in rocks or impervious earth. A knowledge of the geology of the country will greatly assist in tracing this, and the springs may be cut off with greater certainty. But it is not these main springs which give the greatest trouble to an experienced drainer; it is the various land springs which are sometimes branches of the former, and often original and independent springs arising from sudden variations in the nature of the soil and subsoil. The annexed diagram, representing a section of an uneven surface of land will explain the nature of the strata which produce springs.



Suppose A A to be a porous substance through which the water filtrates readily; and B B to be a stratum of loam or clay impervious to water. The water which comes through A A will run along the surface of B B towards S S, where it will spring to the surface and form a lake or bog between S and S. Suppose another gravelly or pervious stratum under the last, as C C C bending as here represented, and filled with water running into it from a higher level; it is evident that this stratum will be saturated with water up to the dotted line E F F, which is the level of the point in the lower rock, or impervious stratum D D, where the water can run over it. If the stratum B B has any crevices in it below the dotted line the water will rise through these to the surface and form springs rising from the bottom of the lake or bog; and if B B were bored through and a pipe inserted rising up to the dotted line, as *c o*, the water would rise and stand at *o*. If there were no springs at S S, the space below the dotted line might still be filled with water rising from the stratum C C C; but if the boring took place at G the water would not rise, but on the contrary, if there were any on the surface, it would be carried down to the porous stratum E C C and run off. Thus in one situation boring will bring water, and in another it will take it off. This principle being well understood will greatly facilitate all draining of springs. Wherever water springs there must a be pervious and an impervious stratum to cause it, and the water either runs over the impervious surface or rises through the crevices in it. When the line of the springs is found, as at S S, the obvious remedy is to cut a channel with a sufficient declivity to take off the water in a direction across this line, and sunk through the porous soil at the surface into the lower impervious earth. The place for this channel is where the porous soil is the shallowest above the breaking out, so as to require the least depth of drain; but the solid stratum must be reached, or the draining will be imperfect. It was by attending to all these circumstances that Elkington acquired his celebrity in draining, and that he has been considered as the father of the system. It is however of much earlier invention, and is too obvious not to have struck any one who seriously considered the subject. In the practical application of the principle great ingenuity and skill may be displayed, and the desired effect may be produced more or less completely, and at a greater or less expense. The advice of a scientific and practical drainer is always well worth the cost at which it may be obtained.

When there is a great variation in the soil, and it is difficult to find any main line of springs, it is best to proceed experimentally by making pits a few feet deep, or by boring in various parts where water appears, observing the level at which the water stands in these pits or bores, as well as the nature of the soil taken out. Thus it will generally be easy to ascertain whence the water arises, and how it may be let off. When there is a mound of light soil over a more impervious stratum, the springs will break out all round the edge of the mound; a drain laid round the base will take off all the water which arises from this cause, and the lower part of the land will be effectually laid dry. So, likewise, where there is a hollow or depression of which the bottom is clay with sand in the upper part, a drain laid along the edge of the hollow and carried round it will prevent the water running down into it, and forming a marsh at the bottom.

When the drains cannot be carried to a sufficient depth to take the water out of the porous stratum saturated with it, it is often useful to bore numerous holes with an auger in the bottom of the drain through the stiffer soil; and, according to the principle explained in the diagram, the water will either rise through these bores into the drains and be carried off, and the natural springs will be dried up, or it will sink down through them as at G, in the section, if it lies above. This method is often advantageous in the draining of peat mosses, which generally lie on clay or stiff loam, with a layer of gravel between the loam and the peat, the whole lying in a basin or hollow, and often on a declivity. The peat, though it retains water, is not pervious, and drains may be cut into it which will hold water. When the drains are four or five feet deep and the peat is much deeper, holes are bored down to the clay below, and the water is pressed up through these holes, by the weight of the whole body of peat, into the drains, by which it is carried off. The bottom of the drains is sometimes choked with loose sand, which flows up with the water, and they require to be cleared repeatedly; but this soon ceases after the first rush is past, and the water rises slowly and gradually. The surface of the pit being dried, dressed with lime, and consolidated with earth and gravel, soon becomes productive. If the soil, whatever be its nature, can be drained to a certain depth, it is of no consequence what water may be lodged below it. It is only when it rises so as to stagnate about the roots of plants that it is hurtful.

When a single large and deep drain will produce the desired effect, it is much better than when there are several smaller, as large drains are more easily kept open and last longer than smaller; but this is only the case in tapping main springs, for if the water is diffused through the surrounding soil, numerous small drains are more effective. But as soon as there is a sufficient body of water collected, the smaller drains should run into larger, and these into main drains, which should all, as far as is practicable, unite in one principal outlet, by which means there will be less chance of their being choked up. When the water springs into a drain from below, it is best to fill up that part of the drain which lies above the stones or other materials which form the channel with solid earth well pressed in, and made impervious to within a few inches of the bottom of the furrows in ploughed land, or the sod in pastures; because the water running along the surface is apt to carry loose earth with it, and choke the drains. When the water comes in by the side of the drains, loose stones or gravel, or any porous material, should be laid in them to the line where the water comes in, and a little above it, over which the earth may be rammed in tight, so as to allow the horses to walk over the drain without sinking in.

It sometimes happens, that the water collected from springs which caused marshes and bogs below, by being carried in new channels, may be usefully employed in irrigating the land which it rendered barren before; not only removing the cause of barrenness, but adding positive fertility. In this case the lower ground must have numerous drains in it, in order that the water let on to irrigate it may not stagnate upon it, but run off after it has answered its purpose.

The third branch in the art of draining is the removal of water from impervious soils which lie flat, or in hollows, where the water from rain, snow, or dews, which cannot sink into the soil on account of its impervious nature, and which cannot be carried off by evaporation, runs along the surface and stagnates in every depression. This is by far the most expensive operation, in consequence of the number of drains required to lay the surface dry, and the necessity of filling them with porous substances, through which the surface water can penetrate.

It is very seldom that a field is absolutely level; the first thing, therefore, to be ascertained is, the greatest inclination and its direction. For this purpose there is an instrument essential to a drainer, with which an accurately horizontal line can be ascertained, by means of a plummet or a spirit-level. A sufficient fall may thus be found or artificially made in the drains to carry off the water. One foot is sufficient fall for a drain 300 feet in length, provided the drains be not more than 20 feet apart. It is evident that the drains cannot always be in a straight line, unless the ground be perfectly even. They should, however, never have sudden turns, but be bent gradually where the direction is changed. The flatter the surface and the stiffer the soil, the greater number of drains will be required. It is a common practice with drainers to run a main drain directly down the slope, however rapid, and to carry smaller drains into this alternately on the right and left, which they call herring-bone fashion. But this can rarely be approved of. It generally happens that, besides surface water, there are also some land springs arising from a variation in the soil: these should be carefully ascertained, and the drains should be so laid as to cut them off.

The following memoranda are suggestive of the principles which should guide practice on the subject; and may serve also to indicate directly what correct practice generally is:—

Food enters plants chiefly as dissolved in water. The relations of water to the plant and to the soil are therefore of the first importance. Water is a powerful solvent, extracting soluble matters from the air and from the soil through which it passes. The air in rain-water contains one half more oxygen, and three to six times more carbonic acid than the air of the atmosphere. Rain-water also contains nitric acid and ammonia.

The contents of rain-water, its solvent powers exerted on the mineral and other matters useful as food for plants in the soil, and its relations to temperature, are the three points on which its fertilising influences depend.

Water gets into land in three ways: 1st, as rain falling on the surface; 2nd, as spring water; 3rd, by capillary attraction exerted on a wet subsoil.

Water leaves the land in three ways: 1st, by running off its surface; 2nd, by evaporating from its surface; 3rd, by percolating through its substance. In the first case it is wholly inoperative, except in so far as it does mischief by carrying off the finer surface particles of the soil either in solution or otherwise. In the second case it carries off, in great measure to waste, matters capable of evaporation, and useful as food for plants, which it holds in solution; but the most considerable result of evaporation is the loss of heat consequent upon it. As much heat as the burning of two or three ounces of coal could produce is lost by the evaporation of 1 lb. of water.—Dalton's gauge indicated an annual evaporation of 24 inches out of 33 inches of an annual rainfall. Dickenson's gauge indicated an evaporation of 15 out of 26. During percolation through the land, which is the third way in which water leaves the soil, it introduces into the land the temperature of the air, it introduces atmospheric elements into the soil, it dissolves food out of the land and carries it to the roots of plants.

The principal practical benefit derived from drainage is the easier and cheaper cultivation of which drained land is capable. The greater fertility of such land is in a measure due to the whole substance of it, its whole internal surface being brought under the influence of air and rain-water.

The object of drainage then is to induce the percolation of rain-water through the soil. To this end conduits are laid under ground at such a depth and at such intervals as experience finds sufficient. And the points connected with the practice to be considered are (1), the depth, as limited by the outfall, as desirable in the interests of fertility, and as necessary owing to the constitution of the soil; (2), the frequency and capacity of the drain to correspond with the rain-fall and, with the character of the soil; (3), the arrangement of the drains, uniform to correspond with the uniformity of the supply in rain, or irregular to correspond with the subsequent irregular distribution of the rain-water throughout the soil.

(1). As to depth—its principal limit is cost—that it should be considerable is desirable on the ground of the greater depth of material being thus fertilised and made useful to the plant. Drains 2 and 3 and 4 feet deep may, other things being equal, cost 3*l.*, and 4*l.*, and 5*l.* per acre—but there are thus brought into use 18, 30, and 42 hundred tons of earth per acre, which is after the rate of 600, 700, and 800 tons for every pound of expenditure—so that the deeper and costlier drain may be the cheaper in the end. But depth is regulated to some extent by the capillary attraction of the soil upon the water which it holds, a considerable height of column to give the weight necessary to force that attraction being required.

(2). The frequency of drains must be greater according to the greater quantity of water falling in a given time as rain, to which the climate exposes the land to be drained, and according to the difficulty of percolation which the land presents. In practice the quantity of exit provided in the least efficient drainage is sufficient for the removal of the largest probable rain-fall. The size of the pipes is determined by other considerations than the quantity of water they have to deliver—a larger pipe is rendered desirable by the fact that when a smaller one is used a very slight displacement breaks the continuity of the pipe.

The interval between drains is to be determined by the rain-fall and the capability of percolation. The depth of drains should be allowed very little influence on the interval. The direction of drains should be right down the slope, simply because when once the water gets into them, the shortest way out of the field is the best.

(3). The arrangement of the drains at varying intervals is necessary sometimes, to suit the varying distribution by which rain-water is accumulated in certain spots, so that springs and swamps are produced.

As a general rule, however, drains as nearly 4 feet deep as may be, and from 5 to 10 yards apart,—greater according to the porosity of soil and subsoil, should be laid parallel to one another, and for the most part straight down the slope. The material used should be the common cylindrical pipe tile, about 2 inches in the bore, less than this at the upper part of the drain, more in the lower.

In commencing drainage, prepare a general plan for the farm or estate. Seek, in the first place, by straightening water-courses and draining springs, to give rapid exit for all the water that comes into the land otherwise than from the clouds. In the after drainage of the land the general rule is to commence the drainage of the lowest part first, attending to the final outfall first of all. There are exceptional cases where the drainage of a higher land may to some extent remove water at once which fed the lower grounds. When spring water is removed, drain as deep (to 4 feet) as the outfall will permit, and with such attention to uniformity of interval as the adhesiveness or porosity of the soil shall indicate. Notwithstanding the outcry against rules and systems in drainage—uniformity of interval *is* the rule, and the so-called "gridiron" system is the safest; departures from either being exceptional.

Before carrying out the system however let all such obstacles and nuisances (crooked hedge rows, old ditches, and timber) as it is intended to remove be removed.

Trial holes are useful to determine the interval which may be desirable between the minor drains. Ascertain the experience of your neighbours on this point. Widen the interval, because the soil admits of the more easy percolation of the water, not because you have made your drains deeper.

The cost of digging 4 feet deep drains 1 foot to 14 inches wide at top to receive a 2-inch pipe at bottom may be from 6*d.* per rod of 5½ yards in homogeneous clays to any greater sum when the pickaxe may be needed. The following Table is taken from Bailey Denton's pamphlet on the subject.

Cost of Drainage, per acre, 4 feet deep (Denton).

(1) Labour of cutting and filling in.
(2) Material—pipes at 18*s.* to 20*s.* a 1000.
(3) Haulage, 2*s.* 6*d.* per 1000.
(4) Pipe laying and finishing, 1*d.* per rod.
(5) Superintendence.
(6) Extra for mains.
(7) Iron outlet pipes and masonry.
(8) Collars if used.

	18 feet apart.			24 feet apart.			30 feet apart.			18 feet apart.		
	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*	£	*s.*	*d.*
(1) 6*d.*	3	13	11	2	15	0	2	4	0	1	13	0
(2)	2	5	9	1	14	3	1	7	5	1	0	6
(3)	0	6	4	0	4	9	0	3	9	0	2	9
(4)	0	12	2	0	9	2	0	7	4	0	5	6
(5)	0	5	0	0	5	0	0	5	0	0	4	0
(6)	0	2	0	0	2	0	0	2	0	0	2	0
(7)	0	1	6	0	1	6	0	1	6	0	1	6
	7	6	1	5	11	8	4	11	0	3	9	3
(8)	1	2	10	0	17	1	0	13	8	0	10	3
Total .	8	8	11	6	8	9	5	4	8	3	19	6
1. 8*d.*	4	17	9	3	13	4	2	18	8	2	4	0
2.	2	13	7	2	0	10	1	13	3	1	5	7
3.	0	6	4	0	4	9	0	3	9	0	2	9
4.	0	12	2	0	9	2	0	7	4	0	5	6
5.	0	5	0	0	5	0	0	5	0	0	4	0
6.	0	2	0	0	2	0	0	2	0	0	2	0
7.	0	1	6	0	1	6	0	1	6	0	1	6
	8	18	4	6	16	7	5	11	6	4	5	4
8.	1	6	9	1	0	5	0	16	7	0	12	9
Total .	10	5	1	7	17	0	6	8	1	4	18	1

Mains may require 4-inch pipes at the outfall, gradually smaller near the upper end. A long minor drain may need 1, 1½, and 2-inch pipes as you approach its junction with the main. Its water should *fall* into the main pipe, and the junction should be with a curve, not abruptly. Open ditches should be avoided if possible. When necessary their sides should slope with a fall of from 1 in 1 to 1 in 2, according to the material. They are necessary as a preliminary drainage in peat soils and bogs. Small open ditches (15 inches deep or so) laid with a regard to local outbreaks of water, are a great and cheap (1¼*d.* per rod) improvement of mountain pasture. Drain stoppages arise very rarely from direct infiltration, generally either by the growth of root fibres, or the formation of peroxide of iron in the drain water. The remedy for the former is extra depth, and care for the joints where the danger is great, and for the latter thorough cultivation by which iron may be peroxidised in the soil, not in the water which drains out of it. A uniform slope in the drains tends to diminish the risk of stoppage, and a small pipe (if large enough) is better than a large one.

Whatever system of drainage be adopted, see that it be thoroughly done. "Nothing is stronger than its weakest part," and a defective patch may check the cultivation of the whole field. Subsoil ploughing across the drainage tends to its immediate and increased efficiency.

In draining fields it is usual to make the outlets of the drains in the ditch which bounds them. The fewer outlets there are, the less chance there is of their being choked; they should fall into the ditch considerably above the bottom, and a wooden trunk, or one of stone, should be laid so that the water may be discharged without carrying the soil from the side of the ditch. If there is water in the ditch, it should be kept below the mouth of the drain. The outlets of all drains should be repeatedly examined, to keep them clear; for wherever water remains in a drain, it will soon derange or choke it. The drains should be so arranged or turned that the outlet shall meet the ditch at an obtuse angle towards the lower part where the water runs to. A drain brought at right angles into a ditch must necessarily soon be choked by the deposition of sand and earth at its mouth.

As the draining of wet clay soils is the only means by which they can be rendered profitable as arable land, and the expense is great, various instruments and ploughs have been contrived to diminish manual labour and expedite the work. Of these, one of the simplest is the common mole-plough, which in very stiff clay makes a small hollow drain below the surface, by forcing a pointed iron cylinder horizontally through the ground. It makes a cut through the clay, and leaves a cylindrical channel, through which the water which enters by the slit is carried off. It requires great power to draw it, and since steam-power has been used for the purpose, strings of pipe-tiles have been drawn in behind the "mole," so as to leave permanent tunnels or conduits at any required depth beneath the surface.

But a draining-plough has been invented which, assisted by numerous labourers, greatly accelerates the operation of forming drains, by cutting them out in a regular manner, when they are immediately finished with the usual tools and filled up. It has done wonders in some of the wet stiff soils in Sussex, and is much to be recommended in all wet and heavy clays. In stony land it cannot well be used. The subsoil plough, introduced to public notice by Mr. Smith of Deanston, may be considered in some measure as a draining-plough, for it loosens the sub-soil, and facilitates the drainage of the land. By means of judicious drains and the use of the subsoil plough, the stiffest and wettest land may in time become the most fertile.

The tools used in draining are few and simple. Spades, with tapering blades of different sizes, are required to dig the drains of the proper width, and the sides at a proper angle. Hollow spades are used in very stiff clay. When the drains begin to be very narrow near the bottom, scoops are used, of different sizes, which are fixed to handles at various angles, more conveniently to clear the bottom and lay it smooth to the exact width of the tiles, if these are used; for the more firmly the tiles are kept in their places by the solid sides of the drain, the less likely they are to be moved.

DRAM, or DRACHM, a small measure of weight, the etymology of which is to be found in the Greek drachma (δραχμή). The dram of our pound troy is stated to be nearly the same as the Attic drachma, or the Roman denarius (under the earlier emperors).

There are two drams remaining in our system of weights; the first is the sixteenth part of the ounce, which is the sixteenth part of the pound avoirdupois of 7000 grains; this is now totally out of use, as no species of goods which are weighed by the avoirdupois weight are of such value as to make the sixteenth part of an ounce worth consideration. In the national standard, the troy pound of 5760 grains, there is no dram; but this weight occurs in that particular division of the troy pound which is used by apothecaries, in which the dram is the eighth part of the ounce, which is the twelfth part of the pound of 5760 grains. This is the real remnant of the Roman division; the denarius (which, according to Pliny, was the Attic drachma of his time) was, however, the *seventh* part of the ounce. The dram is used in England, France, Holland, Prussia, Turkey, and in some parts of the Levant.

DRAMA; DRAMATIC LITERATURE. A complete history of the drama would be almost equivalent to a history of civilised society over the greater part of the earth. Nearly every ancient as well as every modern civilised people, except perhaps the ancient Egyptians, seem to have possessed some kind of dramatic representation. The Hindus have a rich store of dramatic works, extending back to a very remote period. The Sanskrit drama of Sakontala, well translated by Mr. Eastwick, though very beautiful, is not fitted for any stage representation, and in recent times it has had few imitators. The Chinese, according to Sir J. F. Davis ('The Chinese; a general description of the Empire of China and its Inhabitants,' vol. ii.) have a rage for theatrical exhibitions. In their dramas they disregard the unities, depend not at all on scenic effect, divide them into five acts, or rather an introduction and four "breaks," and use rhymes and music. Several of their dramas have been translated into French, English, and German. They show customs and manners, rather than depict characters, and the plots are often ingenious. In this summary we shall not enter into any examination either of the ancient or the existing oriental drama. Notwithstanding the great extent and fertility, the vast population and industry of those remoter Asiatic regions, the spirit of their social institutions, to whatever moral causes originally owing, seems to doom them (external influences apart) to a perpetual stationariness, excluding them as it were from the history of general civilisation, which is essentially the history of progress.

The Attic drama (δρᾶμα, an action), is said by Aristotle ('Poet.' iv., 14) to have arisen from the recitations of the leaders of the Dithyrambus. To understand this statement we must bear in mind that a Greek tragedy always consisted of two distinct parts; the dialogue which was written in the Attic dialect, and corresponded in its general features to the dramatical compositions of modern times, and the chorus, which to the last was more or less pervaded by Dorisms, and the whole tone of which was lyrical rather than dramatical. We must add that the metre of the dialogue, whether Iambic or Trochaic, was staid and uniform while the choruses were written with every variety of metre. In a word, the dialogue was meant to be recited; the chorus was intended to be sung. It is obvious that these two elements must have had different origins. The one was an offshoot of the lyric poetry which sprung up among the Dorians, the other is to be referred to the rhapsodical recitations which were peculiar to the Ionian branch of the Greek nation; and as the Athenians stood in the middle between the Ionians and the Dorians, so the Attic drama may be considered as the point of intersection of the Ionian and Dorian literatures. That choral and consequently lyrical poetry should spring up among the Dorians was a natural result of the peculiar organisation of a Doric state: and the Epos as naturally arose among the Ionians, the countrymen of Homer. ('Hist. of the Literature of Greece,' by Müller, continued by D. Donaldson.) [HOMER, in BIOG. DIV.] The Ionian epic poetry, which was written in dactylic hexameters, was recited by a set of men called *rhapsodists* [RHAPSODY]; and the gnomic and didactic poetry of Hesiod was recited in the same way. But the dactylic hexameter was not found suitable for gnomic poetry, and a modification of it, consisting also of six feet, but each foot shorter by a half-time than the dactyl, was substituted for it. This metre (the Iambic), or a lengthened form of it (the trochaic), was used by Archilochus, Simonides of Amorgus, and Solon, whose verses were recited by themselves or by rhapsodists in the same way as the epic poetry which preceded them.

The lyric poetry of the Dorians was originally appropriated to the worship of Apollo, but the particular odes and choruses used in this worship were in process of time transferred to Dionysus [DIONYSUS]; and these odes and choral dances had, all of them, their representatives in the dramatic poetry of a later age. (Athenæus, p. 630, D.) But the Dithyrambus was the earliest species of choral poetry connected with the worship of Dionysus, and it appears from many allusions, and indeed from Dithyrambic fragments, that while the body of the song was composed in irregular metres, the poet himself, or some rhapsodist, acting as exarchus, or leader, in his place, recited trochaics as an introduction. Here then was a mixture of recitation and chorus perfectly analogous to the tragedy of later time, which was probably suggested by it; and it is in this sense, we doubt not, that Aristotle attributes to the leaders of the Dithyrambus the origin of tragedy.

We read of a lyrical tragedy long before Thespis, and this appears to have been a modification of the Dithyrambus with a lyrical accompaniment instead of the flute-music to which it was originally danced, and with a substitution of men dressed as satyrs for the usual chorus, which alteration is attributed to Arion. The union of this lyrical tragedy with the recitations of rhapsodists is said to have been brought about by Thespis, a contemporary of Pisistratus and Solon, and may have been suggested as well by the recitations of the leaders of the Dithyrambus as by the union of rhapsodical recitations with the Dionysian rites. Thespis introduced one actor, an exarchus, or rhapsodist, who, standing on an elevated place, while the dithyrambic chorus were grouped around the altar of Dionysus, carried on a dialogue with them, or narrated some mythical story in character. The comedy of ancient Greece originated in the festival of the vintage, when the country people went from one village to another, in carts or on foot, and indulging in rude jests and coarse invectives. From these effusions comedy was developed either in Megaris or in Sicily. Its first approach to perfection was owing to the genius of Epicharmus, who is said by Plato ('Theætet.' p. 152, E) to have borne the same relation to comedy that Homer did to tragedy. A similar comic drama sprung up about the same time at Athens, and was carried to a wonderful degree of strength and beauty.

The dramas of ancient Greece were always performed at and as a part of the festival of Dionysus [DIONYSIA]. The plays for exhibition had previously been submitted by their authors to a board of judges, and approved by them.

Æschylus, the true father of the Attic drama (so far at least as we are acquainted with it), was born in Attica about the year B.C 525, and died probably about B.C. 456, having survived the splendid victories of Salamis, Platæa, and Mycale. Thus he may be said to have flourished during the vigorous youth of Athenian liberty and glory.

There are three grand characteristics of tragedy as conceived by Æschylus, that distinguish it widely from the serious drama of modern times. These are, 1. The religious tone which pervades it throughout; 2. The ideal nature of the whole representation; 3. The large part in the composition still assigned to the lyric muse. These three matters we shall endeavour to place in a clear light before the reader, as upon a knowledge of them mainly depends the capability to form something like an accurate notion of the distinctive character of Grecian tragedy.

First, as regards the religious complexion of the Athenian drama. Modern readers, familiarised from their infancy with the names, attributes, and images of the ancient deities, merely as presenting an inexhaustible storehouse of graceful poetic ornament, almost inevitably forget, in turning to peruse any original work of the ancients, that, how much soever their philosophers, their poets, or their priests, might regard their principal divinities in a purely symbolical view, yet that to the minds of the people at large they were real and awful existences, having will, passions, and various kinds and degrees of dominion over the fortunes and the happiness of man. This important fact has not been sufficiently taken notice of in modern accounts of the ancient drama. All the deities, male or female, celestial or infernal, were objects of fear and propitiation: only the inexorable Fates were unappeasable by god or man. Fate, indeed, was the only omnipotence recognised in the mythological system of the Greeks; for Jupiter himself, the ruler of the celestial deities, the sovereign of Olympus, was regarded neither as eternal nor as infinite in power. Nowhere have poetry and her sister arts been more thoroughly devoted to the service of religion than they were in ancient Greece. Thus we find the drama itself lying in embryo in the worship of Dionysus; and when in its maturity it lost the direct character of a religious rite, we shall find the sacred character impressed on tragedy even more solemnly than upon any of the other productions of Athenian genius not primarily devoted to religious objects.

The *ideality* of the scenic representation, as arranged by Æschylus, necessarily resulted from the adoption, in the composition of the drama, of ideal and of nearly ideal characters. "The use of masks," observes Schlegel, "which appears astonishing to us, was not only justifiable on this principle, but absolutely essential; and far from considering them in the light of a last resource, the Greeks would justly have considered as a last resource the being obliged to allow a player with vulgar, ignoble, or strongly-marked individual features, to represent an Apollo or a Hercules. To them this would have appeared downright profanation. . . . . As the features of the player acquired a more decided expression from the mask, as his voice was strengthened by a contrivance for that purpose, so also the *cothurnus*, which consisted of several considerable additions to his soles, as we may see in the ancient statues of Melpomene, raised his figure considerably above the middle standard. The female parts, too, were played by men, as the voice and other qualities of women would have conveyed an inadequate idea of the energy of tragic heroines. The forms of the masks and the whole appearance of the tragic figures, we may easily suppose, were sufficiently beautiful and dignified. We should do well to have the ancient sculpture always present to our minds; and the most accurate conception, perhaps, that we can possibly have, is to imagine them so many statues in the grand style, endowed with life and motion. But as in sculpture they were fond of dispensing as much as possible with dress, for the sake of exhibiting the more essential beauty of the figure; on the stage they would endeavour, from an opposite principle, to clothe as much as they could well do, both from a regard to decency, and because the actual forms of the body would not correspond sufficiently with the beauty of the countenance. They would also exhibit their divinities, which in sculpture we always observe either entirely naked or only half covered, in a complete dress. [We would remark, however, that the *early* Greek statues of divinities were always clothed. It was only when sculptors, thinking to philosophise their art, ventured to treat their deities as means for exhibiting ideal beauty of form, that the figures became nude.] They had recourse to a number of means for giving a suitable strength to the forms of the limbs, and thus restoring proportion to the increased height of the player.

Greek Theatrical Masks.

"The great breadth of the theatre, in proportion to its depth, must have given to the grouping of the figures the simple and distinct order of the bas-relief. . . . . The gestures accompanied the rhythmus of the declamation, and were intended to display the utmost beauty and harmony."

In the syllabic composition, which then at least prevailed in the Grecian music, the solemn choral song had no other instrumental accompaniment than a single flute, which could not impair the distinctness of the words. The choruses and lyrical songs in general form the portion most difficult to understand of the ancient tragedy, and must also have been the most difficult to contemporary auditors. They abound with the most involved constructions, the most unusual expressions, and the boldest images and allusions. Such labour and art would hardly have been lavished upon them by the poets merely to be lost in the delivery. Such a display of ornament without aim is very unlike the mode of thinking of the Greeks. In the syllabic measure of their tragedy there generally prevails a highly finished regularity, which, however, by no means appears a stiff symmetrical uniformity. Besides the infinite variety of the lyrical strophes, they have also a measure to denote the mental transition from the dialogue to the lyric, the anapæst; and two for the dialogue itself, of which the one by far the most general, the iambic trimeter, denoted the regular progress of the action, and the other, the trochaic tetrameter, was expressive of sudden passion. Indeed, the simplicity of the Greek tragedy, of which so much has been said, attaches only to the plan; for the richest variety of poetical ornament is observable in the execution. It must be remembered, too, that the utmost accuracy in the delivery of the different modes of versification was expected from the player, as the delicacy of the Grecian ear would not excuse, even in an orator, the false quantity of a single syllable.

But the epic form, under which their greater and more national compositions present themselves to us in their earlier times, had, for a long period before the rise of the dramatic art among them, been rivalled by the lyric; and many old subjects of high heroic song had been embodied under a new shape in grand choral compositions, which, observes Mr. Thirlwall ('Hist. of Greece,' chap. xii.) "uniting the attractious of music and action with those of a lofty poetry, formed the favourite entertainment of the Dorian cities. This appears to have been the germ out of which, by the introduction of a new element, the recitation of a performer who assumed a character, and perhaps from the first shifted his mask so as to exhibit the outlines of a simple story in a few scenes parted by the intervening song of the chorus, Thespis and his successors gradually unfolded the Attic tragedy."

Such being the firmly established practical circumstances of Greece, a transition all at once from the combined epic and lyric forms to the purely dramatic was, we conceive, neither practicable even to a genius of the first order, as we admit Æschylus to have been, nor very likely even to enter into his imagination. Æschylus by no means introduced the chorus into the drama: he may be much rather said to have introduced the drama into the chorus; and that of itself was no slight achievement. We have already remarked, that the idea of any great public exhibition unaccompanied by choral songs was one into which the Greek taste and imagination of that day could by no means enter. So strong, however, was the bent of Æschylus towards the dramatic, that he not only retains the chorus as a lyrical accompaniment, but gives it also a participation in the action itself. This, in stamping the dramatic character upon the whole performance, was as far as he could venture to go, and, as we have already said, was most likely as far as he desired to go.

We must now, in order to complete the idea which we desire to present of the material forms of the Grecian drama, give a short account of the architectural structure and arrangement of the edifice itself in which the pieces were exhibited, when once, under the hand of Æschylus, their dramatic element was distinctly developed. Brief as we shall endeavour to make this description, some detail is indispensable, owing to the very different plan from the modern upon which the whole conception and design of the ancient drama required that its theatres should be constructed.

The theatres of the Greeks were open to the sky, and their dramas were always acted during the day,—a mode of construction and of exhibition which was highly favoured by the beauty of their climate. As regards the inconvenience which many modern critics have supposed the poets to have felt, from the necessity of always laying the scene of their pieces before houses, and thus often violating probability, it should be observed that the Greeks lived much more in the open air than we do, and transacted many things in public places which with us usually take place in houses; and the stage did not represent a street, but a space before the house and belonging to it, wherein stood an altar on which the sacrifices to the household gods were offered up. Here the women (who among the Greeks lived in so retired a manner) might appear without impropriety, even the unmarried ones. Neither was it impracticable to give a view of the interior of the houses: this was done by means of the encyclema, which we shall presently describe.

The Grecian theatres, destined, not like those of the moderns, for a long succession of daily exhibitions, but for the celebration of a few annual festivals, were of that colossal magnitude which was indispensable to contain, as it were, the whole body of the people, together with the concourse of strangers who flocked to these solemnities. The distance to which the eyes of the spectators were thus necessarily thrown from the acted scene presents another obvious reason for and justification of the artificial expansion, as we may term it, of the whole figure of the actor. The groups on the stage, not to appear absolutely insignificant, needed, if possible, to be represented larger than life; and besides the fundamental reason which we have already stated for the constant use of the mask, that play of the actor's features which it concealed could not have been perceived with any distinctness across the vast space which separated him from the audience. Analogous to the use of the mask, the buskin, &c., were certain contrivances for increasing the loudness of the voice. Vitruvius tells us also of vehicles of sound distributed throughout the building; and though of these we have no very clear account, we may safely assume that the theatres of the ancients were constructed on very perfect acoustical principles. We know from existing remains that all who were present at the dramatic exhibition could be, in the literal sense of the word, spectators. The seats for them consisted of steps rising backwards round the semicircle of the orchestra, the name given to the whole internal area called in a modern theatre the pit. The lowest step of this amphitheatre was raised considerably above the orchestra, and opposite to it was the stage, placed at an equal elevation. The sunk semicircle of the orchestra contained no spectators, but served another purpose, which we shall shortly have to mention. The stage consisted of a strip, which, forming the chord of the semicircle, extended from one end of the building to the other, but the depth of which bore little proportion to this length. This was called the logeum, or, in Latin, pulpitum, and the usual place for the dramatic action was in the middle of it. Behind this middle part the scene receded quadrangularly; still, however, with less depth than breadth: the space thus comprised was called the proscenium. The remaining part of the logeum, to the right and left of the scene, had, both in front on the verge of the orchestra and at the back, a wall entirely plain, or at most architecturally ornamented, which rose to the level of the uppermost seat for the spectators.

The decoration was so contrived that the principal object in front covered the back-ground, and the prospects of distance were given at each side, which is just the reverse of the mode adopted on the modern stage. This was done according to certain rules: on the left appeared the town to which the palace, temple, or whatever occupied the centre belonged; on the right was the open country, landscape, mountains, sea-shore, &c. The lateral decorations were three-sided constructions turning on a pivot fixed underneath, by which means the changes of scene were partly effected. In the back decoration it is probable that many things were exhibited substantially which with us are only painted. When a palace or temple was represented, there appeared in the proscenium an altar, which answered a number of purposes in the course of the performance. The central decoration was most frequently architectural, though sometimes it was a painted landscape; and from a passage of Plato it seems clear that the Greeks must have carried theatrical perspective to very considerable perfection.

In the back wall of the scene were a large main entrance and two side ones; and as the hinder decoration was generally a palace in which the principal characters of royal descent resided, they naturally came through the great door, and the servants made their entrance from the wings. There were two other entrances; one at the end of the logeum, whence the inhabitants of the town came; the other in the orchestra below, for characters who were supposed to come from a distance; they ascended the logeum by a staircase from the orchestra, which was applicable to a variety of purposes, as circumstances required. The situation of these several entrances explains many passages in the ancient dramas, where the persons standing in the middle see some one advancing long before he comes near them. Beneath the seats of the spectators a stair was somewhere constructed through which the spectres of the departed, unperceived by the audience, ascended into the orchestra, and thence, by the staircase above mentioned, made their appearance on the stage. The nearest verge of the logeum sometimes represented the sea-shore. The Greeks were well skilled also in availing themselves, for scenic effect, even of what lay beyond the decorations. The frequent addresses to heaven were doubtless directed to the actual skies; and it was a general principle with them, that everything imitated on the stage should, if possible, consist of actual representation, and only where this could not be done were they content with a symbolical exhibition. The machinery for the descent of gods to the earth or the withdrawing of men from it, was placed aloft behind the wall at each side of the scene, and so removed from the sight of the audience. There were hollow places beneath the stage, and contrivances for thunder and lightning, for the apparent fall or burning of a house, &c. An upper story could be added to the farthermost wall of the scene, when it was necessary to represent a tower having an extensive prospect, &c. The encyclema was a machine semicircular within, and covered above, which represented the objects contained in it as in a house; this could be thrust behind the great middle entrance, and we find it to have been so used for the production of a grand theatrical effect, the central entrance being then left open to exhibit the interior to the audience. A stage curtain is mentioned both by Greek and Roman writers; indeed its Latin appellation, *aulæum*, is borrowed from the Greeks. It seems, however, not to have been in use in the earlier period of the Attic theatre; and when brought into use it covered, not the whole length of the logeum, but only the comparatively small front of the proscenium.

The entrances for the chorus were beneath, in the orchestra, in which it generally remained, and in which it performed its solemn dance, moving round first in one direction, then in the other, during the choral songs. In front of the orchestra, opposite to the middle of the scene, was an elevation with steps, resembling an altar, raised to the level of the stage, and called the thymele. This was the station of the chorus when it did not chant, but was taking an interest in the action. The leader of the chorus then took his or her station on the top of the thymele, to see what was passing on the stage, and to communicate with the characters. For though the choral song was common to the whole, yet when it entered into the dialogue, one of its number spoke for the rest, which accounts for the changing from the plural number to the singular, and *vice versâ*, in addressing them from the stage. The thymele was situated precisely in the centre of the building, and all the measurements were calculated from that point.

It is plain that the Grecian theatre, both in its architectural and its scenic arrangements, must have attained much higher perfection in the course of that illustrious period of Grecian art which we are accustomed to denominate, from its most characteristic and influential name, the age of Pericles, than it had reached at the termination of the dramatic career of Æschylus. The very building itself, which in the general and splendid restoration of Athens after the termination of the Persian war, was reconstructed of massive stone, was originally of timber only. Of the works of the three great masters of the Greek tragedy, Æschylus, Sophocles, and Euripides, a particular account is given under their respective names in the Biog. Div.

We shall, perhaps, form the best idea of the old Grecian comedy by considering it as a complete contrast to the ideal tragedy. Although the old comic writers gave the names of existing persons to their characters, they did not exhibit them on the stage with all the circumstances peculiar to certain individuals; for such historical characters have always with them an allegorical signification; they represent a class; and as their features were exaggerated in the masks, so their characters were overcharged in the composition. Still this constant allusion to the nearest reality, which not only allowed the poet, in the character of the chorus, to converse with the public in a general way, but also to point at certain individual spectators, is of essential import in any view of this species of composition. As the spirit of the elder tragedy delighted in harmonious unity, the old comedy, on the contrary, flourished in a chaotic exuberance, seeking out the most glaring and diversified objects, the most strongly marked oppositions, working up the most singular, unheard of, and even impossible adventures, with the local peculiarities nearest at hand. The comic poet, indeed, as well as the tragic, transported his characters to an ideal element; not, however, to a world subjected to Necessity, but to one where the caprice of an inventive wit prevails without restraint, and all the laws of reality are suspended.

Comedy, in the hands of its Doric founder Epicharmus [Epicharmus, in Biog. Div.], borrowed its materials chiefly from the mythical world. Nor in its maturity did it altogether relinquish that field, as appears from the titles of many of the lost pieces of Aristophanes and his contemporaries. But as a violent contrast between the materials and the form is here quite appropriate, the subjects of the old comedy were naturally drawn from the most serious concerns of public life and the state: the private and family life was only introduced occasionally, and indirectly, with a reference to the public. The chorus, besides that it was essential to the complete parody of the tragic form, also contributed to the expression of that festal gladness of which comedy was the most unrestrained effusion; for, as already observed, in all the popular and religious festivals of the Greeks choral songs were chanted, accompanied by dancing. On some of these occasions we find in the comic chorus such a display of sublime lyrical poetry that the passages might be transferred to tragedy without alteration. It is, however, one deviation from the tragic model, that often there are several choruses in the same comedy, who at one time all sing together and in opposite positions, and at other times change with and succeed each other without any general reference. But the most remarkable peculiarity of the comic chorus is the *parabasis*, an address by the chorus to the spectators, in the name and under the authority of the poet, which has no immediate concern with the subject of the piece. Herein he sometimes enlarges on his own merits, and ridicules the pretensions of his rivals; at other times he avails himself of his privileges as an Athenian citizen, to deliver proposals of a serious or a ludicrous nature for the public good. The parabasis may have owed its invention partly to the circumstance of the comic poets not having such ample materials as the tragic to fill up the intervals of the action, when the stage was empty, with affecting and inspired poetry. But this very departure from the strictness of dramatic form is consistent with the essence of the old comedy; just as an individual, while wearing a droll disguise may, in the same spirit of drollery, venture occasionally to put aside the mask.

Of the Grecian comic writers of the old kind there is but one of whom any work has descended to us, so that in judging of his merits we can have no aid from comparison with other masters. Aristophanes had many predecessors, Magnes, Cratinus, Crates, and others; he was indeed one of the latest comic authors of that school, as he survived even the old comedy itself. This writer, the very singularity of whose escape from the general wreck of the elder comic productions renders him so interesting and valuable to the history of dramatic art, has been very erroneously judged of in latter times, owing to two capital defects in the mode in which modern criticism has been applied to him, namely, the want of sufficiently understanding the spirit of Athenian society of that day in general, and yet more, the want of a just view of what constituted the essential character of the old comedy itself. [Aristophanes, in Biog. Div.]

Towards the end of the Peloponnesian war, when a few individuals, violating the constitution, had assumed supreme authority in Athens, a law was enacted empowering any person attacked by comic poets to bring them to justice; and a prohibition was issued against introducing real persons on the stage, or using masks which bore a resemblance to their features, &c. This measure put a violent and final termination to the genuine old comedy. For a short time after, the endeavour was made to continue the existence of this ideal species under the political restrictions thus imposed; but these shackles were soon found to be fatal to its spirit and popular attractiveness; and this transitional kind, which has since been commonly designated as the middle comedy, soon gave way to the introduction of the new comedy, which, like the later Greek tragedy already mentioned, aimed at presenting a poetic mirror of actual life.

Although the new comedy developed itself only in the brief interval between the end of the Peloponnesian war and the first successors of Alexander the Great, yet the stock of pieces in this kind amounted to some thousands: time, however, has made such ravage among them that nothing remains to us but a number of detached fragments in the original language, often so disfigured as to be unintelligible, besides about twenty translations or copies of Greek originals in Plautus and six in Terence.

The Greek theatre, as we have seen, was originally constructed for the exhibition of the higher walks of the tragic drama; its stage was open to the sky, and exhibited but little of the interior of the houses. Comedy was therefore under the necessity of laying the scene out of doors; and had often to make people come out of their houses to confide their secrets to each other in the streets. It is true that the poets were thus spared the necessity of changing the scene, as it was taken for granted that the families concerned in the action lived in the same neighbourhood; besides that the Greeks, like all other southern nations, lived much more in the open air than we do. The chief disadvantage in this construction of the stage is, the circumscription of the female parts. If the actual manners were to be observed, as the essence of the new comedy required, the secluded life of the fair sex in Greece rendered the exclusion of unmarried women, and of young women in general, inevitable. No females could appear but aged mothers, maid-servants, or courtesans. Hence, besides the necessary sacrifice of so many agreeable situations, this other inconvenience is produced, that the whole piece frequently turns on a marriage with or a passion for a young woman whom the audience never once see from the beginning to the end of it.

The Romans, whose drama immediately follows that of the Greeks, were not led to the invention of theatrical amusements from the want of representations to fill up the leisure of their festivals, and enliven the mind by withdrawing it from the concerns of life; but, in the despondency of a desolating pestilence, against which all remedies seemed insufficient (year of Rome, 391), they had, according to the story, recourse to the theatre as a means of appeasing the anger of the gods, having previously been acquainted only with gymnastic exercises and circus races. The *histriones*, for whom they sent to Etruria, were however merely dancers, who probably did not attempt pantomimic movements, but strove to delight their audience by a display of bodily activity. The oldest spoken plays, the 'Fabulæ Atellanæ,' were borrowed by the Romans from the Osci, the indigenous inhabitants of Italy. [Atellanæ.] They were satisfied with these amusements till Livius Andronicus, somewhat more than 500 years after the foundation of Rome, began the imitation of the Greeks; and the regular compositions of tragedy and the new comedy (the old it was impossible to transplant) were then, for the first time, known in Rome. Thus the Romans owed the first idea of a play to the Etrurians, the effusions of a sportive humour to the Oscans, and the higher class of dramatic productions to the Greeks. They displayed, however, more originality in the comic than in the tragic department.

The Romans had, besides, their peculiar *mimi*. Their foreign name for these small pieces might lead us to conclude that they bore a great affinity to the Greek mimi; however, they differed considerably in form: we know also that the manners portrayed in them had a local truth, and that the subject was not derived from Grecian compositions. The later Greek mimi were dialogues in prose, yet written with a kind of rhythm, not designed for the stage; the Roman were in verse, were represented, and often delivered extempore. Their most celebrated authors in this way were contemporary with Julius Cæsar. These were, Laberius, a Roman knight, and P. Syrus, his freedman and scholar in the mimetic art. Not one of their compositions has descended to us entire. We have, however, a number of sentences from the mimi of Syrus, which, from their internal worth and elegant conciseness of expression, deserve to rank with those of Menander. One entire mimus, which unfortunately time has not spared for us, would have thrown more light upon the question than all the confused accounts of the grammarians, and all the conjectures of modern scholars.

The regular comedy of the Romans was for the most part *palliata*, that is, it appeared in a Grecian dress, and represented Grecian manners. This is the case with the whole of the comedies of Plautus and Terence. [Plautus and Terence, in Biog. Div.] But they had also a *comœdia togata*, so called from the Roman dress which was worn in it. Afranius is celebrated as the principal writer in this department. We have no remains whatever of him; and the accounts of the nature of his works are so very scanty, that we cannot even determine, with certainty, whether the togatæ were original comedies of an entirely new invention, or merely Greek comedies adapted to Roman manners. The latter supposition is the more probable, as Afranius lived in a period when the Roman genius had not yet attempted to soar on the wings of original invention; and yet we cannot well conceive the possibility of adapting Attic comedies, without the most violent constraint, to local circumstances of so very different a nature. The Roman way of living was in general serious and grave, though in private society they showed a great turn for wit and joviality. The diversity of ranks among them was politically marked in a very decided manner, and the wealth of private individuals was frequently not inferior to that of sovereigns; women lived much more in society, and acted a much more important part than among the Greeks, through which independence they fully participated in the overwhelming tide of corruption, and the external refinement by which it was accompanied. With these essential differences in the social system, an original Roman comedy would have been a most interesting phenomenon, and would have enabled us to view those conquerors of the world under an aspect altogether new. That this however was not accomplished in the *comœdia togata*, the indifferent manner in which it is mentioned by the ancients will hardly leave us room to doubt. Quintilian himself tells us in plain terms that the Latin literature was lamest in comedy.

With respect to tragedy, it must first of all be observed that the Grecian theatre was not introduced into Rome without considerable changes in its arrangement; that the chorus no longer had a place in the orchestra (wherein the most distinguished spectators, the senators and knights, now sat), but remained on the stage itself. At the very introduction, too, of the regular drama, Livius Andronicus, a Grecian by birth, and the earliest tragic poet and actor of Rome, in the monodies (lyrical pieces chanted by a single person, and not by the chorus), separated the singing from the mimetic dancing, so that the latter alone remained to the actor; and instead of the former, a boy stood beside the flute-player, and accompanied him with his voice. Among the Greeks in better times, the tragic singing and the accompanying rhythmical gestures were so simple, that one person was sufficient to do at the same time the most ample justice to both. The Romans, however, it would seem, preferred separate skill to harmonious unity. Hence arose their fondness, at an after period, for pantomimes, of which the art was, in the time of Augustus, carried to the greatest perfection. From the names of the most celebrated of the performers, Pylades, Bathyllus, &c., it would appear that those who practised this mute eloquence in Rome were Greeks; and the lyrical pieces which their dancing expressed were also delivered in the Grecian language. Roscius frequently played without a mask, and in this respect probably did not stand alone; but so far as we know, there never was any such instance among the Greeks.

In the tragic literature of the Romans there are two epochs: the first is that of Livius Andronicus, Nævius, Ennius, and also of Pacuvius and Attius, who both flourished somewhat later than Plautus and Terence; and the second, the refined epoch of the Augustan age. The former produced only translators and imitators of Greek models; but it is probable that they succeeded better in tragedy than in comedy. Elevated expression usually appears rather stiff in a language not sufficiently cultivated, although it is attainable by perseverance; but to catch the negligent grace of social raillery, we must ourselves be possessed of humour and refinement. Here, however, as in the case of Plautus and Terence, we have not a single fragment of the Greek originals to enable us to judge of the accuracy and general felicity of the copies; but a speech of considerable length of the 'Freed Prometheus' of Attius is hardly unworthy of Æschylus, and is also, in versification, much more polished than the productions of the Latin comic writers generally are. This earlier style was carried to perfection by Pacuvius and Attius, whose pieces kept their place on the stage, and seem to have had many admirers down to the time of Cicero, and even later.

The contemporaries of Augustus were ambitious of measuring their powers with the Greeks in a more original way. The number of amateurs who attempted to shine in tragic composition was particularly great; and we find mention made even of works of the emperor himself. Hence there is strong reason for supposing that Horace wrote his epistle to the Pisos chiefly with a view to deter those young men from so dangerous a career, as they were probably infected by the prevalent literary passion without possessing the requisite talents. One of the most renowned tragic poets of that age was Asinius Pollio, a man of impassioned disposition, as Pliny informs us, and who, in plastic works, was fond of whatever bore the same character. It was he who brought with him from Rhodes the well-known group of the Farnesian Bull, and erected it at Rome. Ovid, who tried so many departments of poetry, likewise attempted tragedy, and was the author of a 'Medea;' and Quintilian asserts that he proved here, for once, what he could have done had he chosen to restrain himself, instead of yielding to his natural propensity to diffuseness.

These and all the other tragic attempts of the Augustan age have perished. Yet, according to all appearances, the loss to the interests of dramatic art is not very great. The Grecian tragedy had at first to struggle in Rome with all the inconveniences of a plant removed to a foreign soil: the Roman religion was in some degree related to the Greek, though by no means so completely the same as many have supposed; but the heroic mythology of the Greeks was merely introduced into Rome by the poets, and was in nowise connected with the national recollections.

From the sole specimen of the tragic talent of the Romans that remains to us it would, however, be unfair to draw a conclusion as to the productions of better times: we allude to the ten tragedies which go under the name of Seneca. [Seneca, in Biog. Div.]

With pagan Rome fell ancient dramatic art. Nevertheless there are one or two links of connection between the ancient drama and that of the middle ages, which modern writers have not always observed. There are even still existing some fragments of a play in Greek iambics on a Jewish Scripture subject, taken from the Exodus or departure of the Israelites from Egypt. The principal characters are "Moses, Sapphora, and God from the bush," that is, God speaking from the burning bush. Moses delivers the prologue in a speech of sixty lines, and his rod is turned into a serpent on the stage. The author of this piece, a Jew named Ezekiel, is supposed by Warton, the historian of English poetry, to have written it after the destruction of Jerusalem, to inspire his dispersed and captive brethren with hopes of deliverance under a new Moses, and to have composed it in imitation of the Greek drama, at the close of the 2nd century. (See the edition and German translation of L. M. Philipson, Berlin, 1830, 8vo.)

It appears that in the first ages of Christianity any one connected with the theatre was not allowed baptism. Among "the fathers," Cyril declares that when in our baptism we say "I renounce thee, Satan, and all thy works and pomps," those pomps of the devil are stage-plays and the like vanities. Tertullian, in like manner, affirms that they who in baptism renounce the devil and his pomps cannot go to a stage-play without turning apostates. Augustine, Cyprian, Basil, and Clement of Alexandria are no less vehement on the same point; and Chrysostom exclaims loudly against such as could listen to a comedian with the same ears with which they heard an evangelical preacher.

But when the blind zeal of the fathers against all heathen literature had been ironically seconded by the emperor Julian with an edict forbidding any Christian to be taught in the heathen schools or to make use of that learning, two ecclesiastics of that time, of considerable learning, undertook to supply in some degree the deficiency of instruction and entertainment experienced by their Christian brethren from the operation of Julian's law. These were Apollinarius, bishop of Laodicea, and his father, a priest of the same city. [Apollinarius, in Biog. Div.] The latter not only, in treating Scriptural subjects, imitated on a large scale the great epic and lyric poets of Greece, but also turned various historical passages of the Old and New Testament into comedies and tragedies after the Greek model. Gregory Nazianzenus, archbishop of Constantinople, is said to have written plays; one only of those attributed to him is extant, a tragedy entitled 'Christ's Passion;' stated to be an imitation of Euripides, but made up, in fact, of scraps from that author. It is not known whether the religious dramas of the Apollinarii perished so early as some of their other writings, which were ordered to be destroyed for the very common offence of heresy; but certain it is that the species of literary culture which they endeavoured to supply gradually disappeared before the progress of Constantine's establishment.

In the general extinction of polite literature and liberal art, which darkened for so many centuries the moral face of Europe, every trace of truly dramatic performance or composition seems to have disappeared. The Saturnalian pageants—the Feast of Fools, the Feast of the Ass, &c.,—exhibited during that long interval, chiefly at the Christmas and New Year festivities, claim mention here, not as bearing much affinity to, but merely as in some degree filling up the place of, the old theatrical portion of the religious celebrations. To arrive once more at any indication of the general existence of what can with propriety be called a religious *drama*, we must descend to a later period of European history. And as in each of the great nations of modern Europe this religious drama gave way but gradually before that rise of the modern stage which accompanied the revival of letters, and has even, in one of those nations, strongly maintained its ground until very recent times, so as to become permanently incorporated, as it were, with the national theatre, we can most conveniently and effectively give such more particular notice of it in each nation as we have to present to our readers, in combination with the rapid view which we have to take of the rise and progress of the modern stage in each of the five great literary countries of Europe, namely, in Italy, Spain, France, Germany, and England.

Italian Drama.—After the long sleep of the true dramatic and theatrical spirit in the middle-ages, which began to dawn again in mysteries and moralities independent of classical models, the first endeavour to imitate the ancients in their theatre, as in other departments of art and poetry, was made by the Italians. Nevertheless, apart from the religious plays, we find in the earliest dramatic attempts of modern Italy upon secular subjects a thorough independence of the classical rules. It is needless to follow through a series of now unknown names of persons who have written plays or translated them from the ancient classic authors. It will be sufficient to state that the Italians never had a national drama in the higher sense of the word. The comedies of Porta possess some merit, and the plays of Alfieri [Alfieri, in Biog. Div.], composed upon a strictly classical model, are admirable and powerful works, but they have no pretence to nationality, though intended to promote a desire for freedom among his countrymen. The Italians, however, were fond of theatrical representations, and Trissino, Ariosto, Bibbiena, and Macchiavelli, all wrote comedies in imitation of the antique.

But something new was required; and Ottavio Rinnuccini invented the *melodrama*, which more commonly took the name of *opera per musica*, and which we now briefly term the opera. The magic power of this union of music with the romantic drama completed the triumph of the latter among the Italians of the 17th century; for not only was this musical melo-drama thenceforward their prime theatrical favourite, but the ordinary drama itself was no longer tolerated except under the romantic garb, and the Spanish school became for a time the model.

At the same time the public continued their favour to a species of comedy, or rather comic recitation, which in Italy seems to have been in all times peculiarly national. This was called the *commedia a soggetto* or *commedia dell' arte*. It consisted of the mere outline of a dramatic composition, wherein the parts very slightly sketched were assigned to the several performers, who were to fill them up extemporarily. These sketches were called *scenarj*, from their containing merely the argument of each scene: those of the comedian Flaminio Scala were particularly celebrated. Some of these *improvisatori*, especially those who appeared in the standing masks of Arlecchino, Pantalone, Puncinella, &c., displayed a liveliness of humour which, in spite of the great mass of empty buffoonery by which they were accompanied, made this kind of performance long continue to be well received by the Italians, until the more general cultivation given to the higher dramatic departments, and the general advance of social refinement, caused the improvisatory masks to be finally abandoned to the populace.

The task of classicising the musical drama was undertaken first by Apostolo Zeno, and afterwards, with more success, by the Abate Metastasio. [ZENI (*Apostolo Zeno*), and METASTASIO, in BIOG. DIV.] They were both of the French school, though Metastasio borrowed much of his intrigue from the Spanish dramatists, especially from Calderon, but failed to impart the spirit. Goldoni, about 1750, began to produce at Venice his comedies, formed generally on the French models [GOLDONI, in BIOG. DIV.], and displayed such abundant nature and fertility in painting the manners and the follies of his own age and country, that at length he brought the comedy of *character* into vogue, to the discredit both of the improvisatory farce and the melodrame. His first successes, however, received a severe check. The injury sustained by the masked and improvisatory comedy, for which the company of Sacchi in Venice had the highest talents, was one of the causes that led to the production, at this period, of the fantastic dramas of Gozzi. [GOZZI, COUNT CARLO, in BIOG. DIV.] These are fairy tales in a dramatic form, in which, however, along with the wonderful, versified, and serious part, this author introduced the whole of the masks, and allowed them the most unrestrained development, and the extravagant caricature of the Italian masks formed an admirable contrast to the wild wonders of the fairy tale.

In the latter period of the last century, Alfieri opened a new æra of Italian tragedy. [ALFIERI, in BIOG. DIV.] He adhered indeed to the established classic school, took his subjects chiefly from ancient story, and was a strict observer of the unities. Since his time MONTI and MANZONI are the only names that require to be mentioned among dramatic writers.

Spanish Drama.—In Spain, as elsewhere, it was the church that gave birth to the modern drama; but this remarkable circumstance is peculiar to Spain, that while in the other great nations of Europe the mature development of the drama detached it wholly from the service of religion, in the peninsula, on the contrary, the greatest dramatic geniuses constantly devoted a large portion of their efforts to religious compositions for ecclesiastical purposes; and the most perfect of all the Spanish theatrical poets made such compositions his favourite occupation. Owing to this very striking peculiarity of the Spanish stage, the source of which also will be indicated below, we defer some further notice of the spiritual plays of the Spaniards until we come to particularise the several species of their dramatic productions as exhibited in the most advanced period of their theatre.

The earliest performance that can strictly be called theatrical of which we find any mention in the Spanish annals, is that exhibited in 1414 at the coronation festival of Ferdinand the Good, king of Arragon. It was from the pen of the Marquis de Villena, a man who possessing intellectual acquirements prodigious for the time in which he lived, marched boldly, as a writer, in advance of his age and nation—so boldly, indeed, that all his writings were burned after his death, and this piece among them, so that its very title has perished. We only learn that it was an allegorical play, wherein figured the personages of Justice, Peace, Truth, and Clemency; so that it seems to have belonged to the class of *moralities* in vogue for a while in the infancy of the Spanish drama, and which Cervantes afterwards revived. Shortly after this attempt of Villena, his friend, the Marquis de Santillana, a man of equally extensive knowledge, and of equal freedom both of thought and pen, dramatised, under the title of 'Comediete de Ponza,' the incidents of a naval action which took place in 1435, near the island of Ponza, between the Genoese and the Arragonese, and in which the latter were defeated. This piece was never acted, nor was it printed among the author's works; its title, quoted in his letters, was all that was known of it until Sr. Martinez de la Rosa about thirty years ago discovered it among the manuscripts in the Royal Library of Paris. This interesting relic of the earliest efforts of the dramatic genius of Spain exhibits remarkable skill in the handling of an historical occurrence, as well as great beauty of plot, dialogue, and versification.

It was near the close of the 15th century that a sort of theatre was first established in Castile. The earliest dramatic attempt in this division of the peninsula was made by Juan de la Encina, who excelled in light poetry, and whose numerous works form a cancionero of themselves. After extending the field of religious representations by composing for exhibition on festival days a number of autos, wherein we find not mere paraphrases of Scripture, but conceptions of the poet's own, together with a certain dignity of action and language, he formed the project of carrying the stage beyond the walls of the church. With this view he composed some small pastoral pieces, which he denominated eclogues. These pieces, in which he himself enacted the principal parts, were first exhibited at the houses of the Admiral of Castile and the Duchess del Infantado. As their name indicates, they consisted of nothing more than a dialogue between two or more shepherds. The author, imitating Virgil, used this expedient in the first instance to celebrate, by means of allusion, some particular event, such as the conclusion of a peace, or the return of a prince: and next, he invented some short and simple action wherein he brought into play the passions of his interlocutors themselves. These little pieces, interrupted by dances and ending with songs (villancicos) usually contained also some farcical scenes; so that they may be said to have comprised at once the elements of the comedy, the ballet, and the vaudeville; and they have in them much grace and wit, as well as nature and liveliness. The first performance of these pastoral comedies took place in the year 1492, so memorable in the Spanish annals as being that of the conquest of Granada and the discovery of the New World.

About the same time appeared the famous 'Celestina,' begun by Rodrigo Cota and finished by Fernando Rojas de Montalvin. Though entitled a "tragi-comedy," it was never performed, nor was it capable of being so, as it was in reality but a tale told in dialogue. Yet the singular merit of this truly primitive composition, which went through several editions, and was translated into almost every European language, contributed much to the advancement of the stage by furnishing a genuine model of dramatic diction.

It was in the beginning of the 16th century that to these various attempts succeeded the first regular Spanish dramas, but, through a singular concurrence of circumstances, they appeared out of Spain. Bartolome de Torres-Naharro, long a captive in the hands of the Moors, and residing at Rome after his redemption, there composed some comedies in his native language, and got them performed at the tasteful and voluptuous court of Leo X. In the compositions of Torres-Naharro, though little known, and unjustly depreciated by Signorelli in his 'Historia Critica del Teatri,' there is much happiness of invention, well-drawn character, and spirited dialogue; they have also the licentious tone of the Italian comedies of that period, and contain some strokes of a malicious boldness peculiar to the author, who, though a priest, and living at the pontifical court, composed satires against the church such as Luther himself might have dictated. He also invented the introïto, or prologue, and gave to the acts the name which they have ever since borne, of jornadas, that is, journeys or stages, alluding to the pauses or resting-places for the actor and the spectator.

No sooner did Naharro's pieces find their way to Spain (about 1520) than they were proscribed by the Inquisition, so watchful to extirpate every trace of Protestantism. The like sentence fell upon those written shortly after in Germany by the author of the 'Satire on Women,' Cristoval de Castillejo, secretary to the emperors Maximilian and Ferdinand. These latter pieces, which it was not deemed prudent to publish among the author's works when the prohibition was taken off in 1573, but which are known to have been of the satirical and licentious class, are entirely lost. So that the Spanish stage presents the singular phenomenon of having really had two infancies. The first attempts in regular dramatic composition being suppressed by the formidable authority above-mentioned, found no imitators, and even seem to have been completely forgotten, for it was a play of Ariosto's that was exhibited at the marriage of an infanta in 1548. Some few classical scholars, indeed, as Villalobos, Fernan Perez de Oliva, and Simon de Abril, strove to bring forward the ancients as dramatic models, by translating Plautus, Terence, and Aristophanes; but their works were still less adapted to take possession of the national mind. So that while, of those dramatic productions which Spain already possessed, one part lay hidden in the libraries of a few of the learned, and the other buried in the archives of the Inquisition, the people were abandoned to the gross merriment of the jugglers and buffoons. Hence it is that Schlegel, Bouterwek, Sismondi, and almost every other foreign critic, apparently ignorant even of the names of the first dramatic writers of Spain, make no mention of them, but fix the middle of the 16th century as the period of the earliest origin of the Spanish drama.

The founder of the truly national and popular theatre of Spain was Lope de Rueda, of Seville, who quitted his trade of a goldbeater to join a company of strollers, of whom he shortly became the chief, or, according to the Spanish expression, the *autor*. This title, derived, not from the Latin *auctor*, but from *auto*, an act or performance, was at that time given to one who composed and recited pieces, and is still retained to signify the manager of a company of comedians. Lope de Rueda united the two kinds of talent necessary to an *autor* of that period; had prodigious success; was unanimously declared to be both a great poet and a great performer; and the grandees of the time crowded to the diversion which his exhibitions afforded them from the gloomy gravity of the palace of Philip II. The few of his plays, pastoral dialogues, &c., that remain, are distinguished for natural grace and liveliness; and though these are all in prose, he wrote with equal facility in verse.

"In the time of this celebrated Spanish actor," says Cervantes in the preface to his own published plays, "the whole wardrobe of an *autor* could be thrust into a bag: there were three or four close vests of white skin trimmed with gilt leather, and the like number of beards, wigs, and trunk hose. The plays were colloquies in the manner of eclogues, between two or three shepherds and some shepherdess, and were eked out with two or three interludes (*entremeses*) exhibiting sometimes the character of a negress, sometimes of a bravo, sometimes of a simpleton, sometimes of a Biscayan; for these characters and many others Lope represented with the greatest truth and perfection imaginable. At that time there were neither machinery, nor decorations, nor combats between Moor and Christian, on foot or on horseback: there were no figures made to issue through the boards of the stage as from the centre of the earth; still less were any angels or souls let down from heaven upon clouds. The stage consisted of four planks, laid in a square form across four benches, which raised them four hands from the ground. The whole decoration consisted of an old coverlet, which was drawn from one end to the other by two cords, to make what was called the *vestiario*, or dressing-room, and behind which were the musicians, who sang, without the guitar, some ancient *romance*."

Shortly after, Juan de Malara, a celebrated professor of the *humanities*, caused a versified drama of his, entitled 'Locusta,' which he had written at first in Latin, to be acted at Salamanca. Then came an actor of Toledo, named Navarro, who, Cervantes tells us, converted the manager's clothes'-bag into the more important-looking form of trunks and portmanteaus; brought forth the music from behind the hanging; took the false beards from the chins of those whose parts did not require them; invented machinery, clouds, thunder and lightning, duels and battles. Moral development, too, accompanied this material progress: the pieces now began to display something like a plot, and some of the animation which arises from conflicting interests and passions. The titles of a few of these may afford some notion of this transitional, or, more properly, adolescent period of the Spanish theatre: there were, for instance, 'Dido and Æneas, or the Pious Trojan,' 'The Grand Prior of Castile,' 'Loyalty against One's King,' 'The Sun at Midnight and the Stars at Noon,' 'The Taking of Seville by St. Ferdinand,' and 'The Cortes of Death;' the costume of which latter piece is so humorously described in a passage of the second part of Don Quixote.

About 1580 were established at Madrid the two theatres *de la Cruz* and *del Principe*, which are still existing; and now some superior minds turned their efforts to dramatic composition, which had hitherto been left entirely to the managers of strolling companies. Cervantes, just returned from his eventful Algerine captivity, was one of the earliest adventurers in this career. "I was the first," he tells us, "that exhibited the imaginings and hidden thoughts of the soul, by bringing forward moral characters on the stage, which I did with warm and general applause from the public. I wrote at that period some twenty or thirty plays, which were all acted unsaluted by cucumbers or any other matters convenient for pelting with; they ran their course free from hissing, shouting, or clamour." Cervantes, indeed, advanced the Spanish drama most importantly, both as to dramatic invention and moral dignity. His 'Numancia,' in particular, one of the only two of these his earlier dramatic productions that have found their way to the press, is very remarkable in the dramatic history of Europe. [SAAVEDRA, in BIOG. DIV.]

Cervantes wrote at Madrid; and at the same time Juan de la Cueva produced some dramas on the stage of Seville, reducing to four the number of jornadas, or acts, which had hitherto been five or six. The day's performance then consisted, besides the principal piece, of three *entremeses*, or interludes, played between the acts, and a little ballet. Valencia, too, which had always, in arts and letters, its rival school to that of Seville, made some advances in the dramatic career. It was a Valencian poet, Cristobal de Virues, who further reduced the number of acts from four to three, which latter number was thenceforward adhered to by all Spanish writers. "Until then," according to the ludicrous conceit of Lope de Vega, "the Spanish drama had *gone on all fours*, like a child, because it was yet in its infancy."

The scenic pomp of the Spanish theatre had already made great progress. The same writer, Rojas, who said that in the days of Lope de Rueda an *autor* and his company might have deposited their bundle of *properties* upon a spider's back, relates that in the time of Cueva and Virues, women played their parts in dresses of silk and velvet, with chains of gold and pearls; that, in the interludes, airs were executed by three or four voices; and that even horses were introduced in the warlike plays to complete the illusion.

It is well worthy of remark that already, in the 16th century, we find in Spain the contest fully and warmly engaged between the claims of the dramatic writers to an absolute independence of the classic rules, and the critics demanding a rigid adherence to the precepts of Aristotle. Thus while the rhetorician Pinciano was zealously conjuring the theatrical writers to respect the unities, for which they showed little regard, one of them, Juan de la Cueva, openly undertook, in his 'Exemplar Poetico,' the defence of the dramatic liberties. He claimed them as the offspring of that succession of ages which had abolished all antique laws,—as more favourable to the boldest flights of imagination,—and in fine, as better adapted to please the public. But, while delivering this judicious opinion, he lays down such maxims for the regulation of this dramatic freedom as good sense and good taste must ever dictate, though his countrymen, in their fiery impatience of any such restriction, have not paid them sufficient attention.

The Spaniards had conquered the Moors, they had subdued South America, but they had lost the more important part of their liberties, and they had become the willing slaves of their church. They had glorious recollections, with an indomitable personal pride, and they still retained a varnish of their old manners and feelings. It has been well observed by Mr. H. Chorley, in some ingenious papers on the Spanish drama in 'Fraser's Magazine,' for 1859, that there is no understanding the Spanish drama after the time of Lope de Vega, without a thorough understanding of the national character. The English reader who meets with heroes who lie, seduce their friends, wives or sisters, and murder those who even seek interviews with their own; who possess few or no estimable qualities, but a frantic bravery and readiness by fighting to wash out in the blood of their adversary any spot on their honour that has been brought to light, cannot but consider them as unnatural, unless they recollect that these crimes were held to be venial if accompanied by an unswerving faith in the power of the church to pardon them, and a belief in the might of a miraculous interposition of their adopted saints.

The Spanish drama attained its greatest excellence about the same time that it flourished in England; and by some an affinity has been claimed. There is, in fact, but little resemblance except in the freedom of both from the conventional classical rules. A most essential difference is pointed out by Mr. G. H. Lewes, in his 'Spanish Drama' (Knight's 'Weekly Volumes,' 1846), in the one being an evolution of plot, the other an evolution of character and passion; that the one, so far resembling the drama of other southern nations, is *objective*, the other, like most of the northern nations, *subjective*. He says, "Calderon and Shakspere are the opposite poles of intellectual action. The tendency of the Spaniard is to transform all thoughts into sensations; that of the Englishman to transform all sensations into thoughts." The Spanish drama depicts personifications or actions, but developes none of the subtler traits of character. The Spanish people admired a devoted loyalty to their monarch, a blind faith in their religion, and unquailing courage. These constituted a hero. In a somewhat milder form these requisites were also necessary to their heroines.

Such was the public mind upon which Lope de Vega arose to exercise his marvellous fertility of dramatic invention and facility of metrical composition. He had the first great requisite for success in this career, a most thorough knowledge of the tastes and passions of the people for whom he wrote; but that further and nobler merit, an elevated view of his art and deep devotion to it for its own sake, he never evinced. [VEGA, LOPE DE, in BIOG. DIV.] Contemporary, or nearly so, with Vega, there were many imitators of him, but none who approached him in excellence. But near the close of his life arose CALDERON DE LA BURCA [BIOG. DIV.], who was destined to supersede him, or nearly so, in the estimation of his countrymen. To him succeeded Moreto, who, with less of the national fire, paid somewhat more attention to the development of character in his plays; and Gabriel Telles, who wrote under the assumed name of Tirso de Molina, whose plays are chiefly remarkable for their want of gaiety, and a frequent disregard of probability. [TELLEZ, in BIOG. DIV.]

It is remarkable that during this, the most brilliant period of the Spanish stage, the council of Castile ventured to propose, as a condition of the re-opening of the theatres, which, on account of court mournings, had remained shut from 1644 to 1649, that the plays to be performed should be confined to subjects of good example taken from edifying lives and deaths, without any mixture of love; that consequently, nearly all those which had theretofore been acted should be prohibited, especially the works of Lope de Vega, which had been so prejudicial to good morals. But fortunately, the taste of the monarch, in accordance with that of the public, made him reject the proposal of his austere advisers.

The patronage of the monarch, the court, and the nation, had thrown a multitude of literary men into that career, then the most honoured and the most lucrative. Thus, besides Moreto, who has been considered as one of the models of Molière, there were a host of dramatists of the second order, at the head of whom must be ranked Francisco de Rojàs, who had all the qualifications of Moreto, but exceeded him in his defects. Then follow Guillen de Castro, Ruis de Alarcon, La Hoz, Diamante, Mendoza, Belmonte, the brothers Figueroas (who wrote conjointly, like the French vaudevillists of the present day), Cancer, Enciso, Salazar, and Bances Candamo, each of whom, though establishing no school, produced at least some important composition.

The disasters that befel the Spanish monarchy in the latter years of the reign of Philip IV., together with a succession of court mournings which closed the theatres for a considerable time, gave the first blow to the dramatic art in Spain. In 1665, the death of that prince, who had been its most zealous protector, gave the signal for its rapid and thorough decline. His successor, the imbecile Charles II., was yet in his infancy; and the queen-regent signalised the commencement of her administration by a decree, dictated no doubt by her spiritual director, the jesuit Nitard, and certainly unique in dramatic history; she commanded "that all plays do cease until the king my son shall be old enough to be entertained by them." Although this strange order could not be rigorously executed, yet the decay was so great that, in 1679, at the marriage of Charles II. with a niece of Louis XIV., wherein all possible magnificence was displayed, no more than three companies could be got together to perform at court.

During this period one writer alone endeavoured to support the tottering stage; Solis, the eloquent historian of the conquest of Mexico, likewise devoted to the service of the theatre his brilliant imagination, polished wit, and glowing style. He has left us several plays well worthy of the dramatic period which he survived, one of which especially, entitled 'Love à la Mode' (El Amor al Uso), has peculiar excellence.

With Solis may be said to have expired the Spanish theatre properly so called. The elevation of Philip V. to the throne of Spain having given prevalence to the French taste, and introduced, at court at least, the habits and manners of the court of Louis XIV., the Spaniards, after having been the dramatic precursors and teachers of the French, were content to become their humble translators and copyists. In the course of the 18th century, it is true, some attempts to re-erect a national drama were made successively by Zamora, Luzan, Canizares, and Jovellanos; but these honourable endeavours had but a transitory success; and to arrive at a work of originality—after, however, noticing as such the *sainetes* (small satirical pieces) of Ramon de la Cruz—we must come down to the commencement of the present century, to Moratin, the witty and elegant author of 'The Coffee-house,' 'The Baron,' 'The Maiden's Yes,' &c., and next, to Martinez de la Rosa, who wrote 'The Mother at the Ball and the Daughter at Home.'

The few specimens of the Spanish drama in the classic style, consist chiefly of translations from, or adaptations of, plays from the Greek, the Italian, or the French; and although occasionally a mixture of the romantic was introduced, they never became popular, and are not worth enumerating.

Although the performance of the *autos sacramentales* on the ordinary stage was suppressed in 1765, in the reign of Charles III., yet the seasons of Advent and Lent, and more especially the Holy Week, are still solemnised by the like representations in the great churches; a sort of stage, called *the monument*, is erected in the choir, upon which are played the acts of the Passion, wherein the numerous characters that successively figure in the piece still wear the costume of the middle ages as it must have been at the origin of these exhibitions,—san-benitos, black masks, high pointed caps, long skirts, belts, or rather breastplates, made of cords,—all the wardrobe, in short, of an *auto-da-fe* procession.

French Drama.—In France the *mysteries* appear to have had their immediate source in the pilgrimages so common in those days. Menestrier tells us ('Représentations en Musique Anciennes et Modernes') that the pilgrims to the Holy Land, St. James of Galicia, Mont St. Michel in Normandy, and the various other places of pious resort in France and abroad, used to compose rude songs on their travels, wherein they introduced a recital of the life and death of Christ, or of the last judgment: in others they celebrated the miracles of saints, their martyrdom, and divers wonderful visions and apparitions. These pilgrims, going in companies, and taking their stand in the streets and public places, where they sang with their staves in their hands, and their hats and mantles covered with shells, and painted images of various colours, formed a kind of spectacle which pleased the public of that day, and at Paris excited the piety of some of the citizens to raise a fund for purchasing a proper place in which to erect a stage whereon these performances might be regularly exhibited on holidays, as well for the instruction of the people as for their entertainment. This appears to have been the origin of the society at Paris called the Brethren of the Passion. In 1402 Charles VI. authorised these exhibitions by letters patent; the Premonstratensian monks gave the use of a great hall of their convent, and a stage was constructed in it upon which the fraternity enacted scriptural pieces. The ecclesiastics crowded to these exhibitions; stages soon arose in every province; and the *mystères* were so much relished, that on holidays the hour of vespers was hastened, that the people might have more ample time to be present at the play. The brethren, to vary the attractions of the performance, added a sort of farcical interludes or after-pieces of a merely worldly character, the enacting of which however, careful of their own histrionic dignity, they delegated to a junior society called that of the *Enfans sans Soucis.* These latter pieces, in allusion to their burlesque and buffoon character, were denominated *sottises* or *soties.*

The stage upon which the mysteries were played consisted of several scaffoldings one above another: the most elevated of all represented heaven; that immediately beneath it, earth; a third, still lower, the palace of Herod, the house of Pilate, &c.; and hell, which was at the bottom and in front, was figured by the gaping mouth of a dragon, which opened and shut as the devils went in and out. On each side were seats rising in steps one above another, on which the actors rested when they were not upon the stage, a contrivance not very favourable to scenic illusion; and at the back was a recess, with curtains drawn across it, for the exhibition of such matters as were supposed to take place in the interior of a house.

Among the French, as elsewhere, the Passion was the primary, the most constant, and most solemn subject of these representations; the parts of Christ on the cross, Judas hanging himself, &c., being all played by real persons, sometimes at the actual peril of their lives. It seems to have been owing chiefly to the efforts of the early reformers to diffuse a knowledge of the Scriptures among the people that the Romish ecclesiastics throughout Europe, as one means of securing the fidelity of their flocks, proceeded studiously to extend the field of the religious representations so as to embrace the whole series of Old and New Testament history, or as much of that history as they deemed it prudent to disclose to the multitude. This zealous exertion on the part of the Catholic clergy was supported by all the authority of the Catholic princes. Thus we find that in 1541, under Francis I., the performance of a grand mystery of the Acts of the Apostles was proclaimed with great solemnity under the royal authority, and acted at Paris in the course of many successive days, before the nobility, clergy, and a great concourse of people, in the Hôtel de Flandres. These plays, written in French rhyme by the brothers Greban, were printed in 2 vols. folio, black letter, under patent of the king to one Guillaume Alabat, of Bourges. The dramatis personæ are, God the Father, the Son, and the Holy Ghost; the Virgin and Joseph; archangels, angels, apostles, and disciples; Jewish priests, emperors, philosophers, magicians, Lucifer, Satan, Beelzebub, Belial, Cerberus, and a multitude of other celestial, terrestrial, and infernal personages, amounting altogether to nearly five hundred. The subjects of these plays are chiefly scriptural; but many of them are from apocryphal New Testament subjects, and the whole forms a strange medley of sacred and profane history. This grand performance was executed, not by any standing company, but by actors selected from the people at large after trial of the merits of the respective candidates.

Among the numerous legendary pieces, one of the most curious extant is 'The Mystery of the Knight who gives his Wife to the Devil' (Le Mystère du Chevalier qui donne sa Femme au Diable); but the most universally popular of them all seems to have been that of the miraculous host, or consecrated wafer, tortured by a Jew at Paris, commonly called 'Le Mystère de la Sainte Hostie,' two several versions of which exist in black letter.

After the *mystères* and the *soties*, and during their continuance, came the *moralités* and the *farces*, of which the clerks of the Basoche were the inventors. These clerks were the young assistants of the procureurs, or solicitors, to whom Philippe le Bel granted the privilege of choosing from among themselves a chief, to be called their king, to have supreme jurisdiction over their body, and even to coin money for currency among the clerks. Francis I., in requital of the service rendered him by the king of the Basoche and 6000 of his clerks in marching against the revolters of Guienne, presented them, in 1547, with an extensive promenade ground, bordering on the Seine, which thence took the name of *Pré aux Clercs.* As early as the commencement of the 15th century, the king of the Basoche used every year, in July, to make a review of his clerks, divided into twelve bands under as many commanders. After the review they went and offered their salutations to those gentlemen at the head of the legal profession who composed the parliament of Paris; and then they went and performed a morality or a farce. The brethren of the Passion having the exclusive privilege of acting mysteries, the clerks were driven to the invention of the moralities, which were purely allegorical pieces personifying the vices and virtues. The farces and the soties, on the other hand, took a satirical turn, the success of which soon carried the authors to licentious extremes. The public calamities and violent political dissensions of the reigns of Charles VI. and Charles VII. favoured this tendency: the two leading parties, the Armagnacs and the Burgundians, had each its poet, and insulted each other by turns upon the stage. When public order was restored, the royal authority availed itself of the fair pretext which these satirical excesses afforded to suppress this exclusively popular stage altogether: the clerks were forbidden to play either farce, sotie, or morality, on pain of flagellation and banishment. This suspension continued until the reign of a prince who was less afraid to hear the truth.

The society of the *Enfans sans Soucis*, too, already mentioned, had been established under Charles VI., had been authorised by patent, and had suffered political oppression. Louis XII. took them likewise under his protection; and their most celebrated sotie, entitled 'The Abuse of the World' (L'Abus du Monde) is attributed to the historian Bouchet above quoted. Their farces have been more celebrated, especially that of 'Pathelin,' whose name has ever since been proverbial in France. The dialogue itself, written in octosyllabic rhyme, is full of humour; and from one passage it may be mentioned that Lafontaine has taken his charming fable, 'Le Renard et le Corbeau.' This piece, with all its levity, is very interesting, as one of the most truly original and national productions of the early French stage, and therefore as one of those which gave promise of something like that spontaneous and vigorous dramatic growth which was springing up in one or two neighbouring countries. But the three several kinds of theatre which we have particularised were fated soon to sink under the repeated blows aimed at them by the government. To this determined stifling by the government of the first germs of a truly national drama we ought to attribute the immediate and general success of the earliest French imitations of the ancient theatre that were actually brought upon the stage. The national taste—the *romantic* tendencies of which had decidedly manifested themselves—was not suffered to develop itself freely. Theatrical enjoyment, since they first tasted it, has ever appeared a more imperious *want* of the French, and of the Parisians in particular, than of any other people, excepting perhaps the ancient Athenians; and when, at the period in question, their rulers had violently crushed every other species of dramatic production, they eagerly welcomed those only forms of it which those rulers would vouchsafe to let them have.

Some French translations from Sophocles and Euripides already existed, but nobody had yet thought of adapting them to the stage; indeed they were little to the purpose either of the brethren of the Passion or the performers of the Basoche. A young gentleman, Etienne Jodelle, seigneur of Limodin, who had studied the ancient dramatists both in their original works and in the Italian imitations of them, was the first to avail himself of the opportunity thus afforded, by bringing forward his 'Cléopatre Captive,' a tragedy in five acts, with choruses after the manner of the Greeks. His friends got a stage erected in the Hôtel de Reims at Paris; two poets of note in that day, Remi Belleau and Jean de la Péruse, undertook the principal male parts; and Jodelle himself, trusting to his youth, his personal beauty, and histrionic talent, personated Cleopatra. This piece is remarkable only as being the first of its class, and so commencing a new era of French dramatic history. Jodelle was more successful in his comedy entitled 'L'Abbé Eugène,' in which there is much comic power and sprightliness.

From Jodelle down to Corneille, French dramatic art made little progress; but dramatic productions, in the same line of classic imitation, abounded, especially in tragedy, the heroes of which were constantly taken from Greek or Roman history, or at most from that of the Turks, who were first introduced upon the stage by Gabriel Bonnin. At this early period, indeed, of the French theatre, that singular dramatic prejudice seems to have firmly established itself, that the pomp of tragic style could not be well supported on the stage, except both costume and character were either Greek, Roman, or Mussulman. The Alexandrine verse, too, was almost invariably used; though once, and but once, was acted a prose tragedy of 'Sophonisba,' by St. Gelais. The versified comedies of the same period have nothing remarkable; but in 1562 the two brothers De la Taille began to accustom the French public to comedies in prose. Nicolas Filleul attempted unsuccessfully to naturalise pastoral poetry on the stage. All these writers had still to contend against the privileged possessors of the stage. There was not in all France a single company regularly trained for the new class of performances. Under Henry IV., the brethren of the Passion had obtained almost a revocation of the edict of 1548, which prohibited them from enacting religious subjects; but the public had now little relish for these rude exhibitions, so that the fraternity found themselves obliged to let their theatre to a more modern class of performers. The other dramatic societies endeavoured to adapt their antiquated pieces in some degree to the modern taste; and thus out of their old moralities they contrived to make pastoral pieces wherein the Church was a bride, and Christ the bridegroom. Robert Garnier rose in tragedy some little above his predecessors in elegance and dignity, and was so much celebrated in his own day as to have the pre-eminence of his tragic powers commemorated in one of the best sonnets of Ronsard. Though he usually drew abundantly from Sophocles, Euripides, and Seneca, he showed in some of his pieces more original vigour, as, for instance, in 'Les Juives,' taken from Jewish history. The prose comedy of intrigue (for the comedy of character had not yet appeared) continued to be cultivated with vigour and success by Pierre de l'Arivey, contemporary with Garnier. The Jesuit father Fronton attempted a tragedy on the grand national subject of 'Jeanne d'Arc,' but without success. At length, in 1600, two permanent theatres were erected at Paris, one of which was occupied by a company which took the title of *Troupe de la Comédie Française;* the other company established itself in the quarter of Paris called the *Marais*, with the consent of the brethren of the Passion, and thus the old stage of the middle ages was finally extinguished in the French metropolis. Still, however, as before, the theatre took its tone from the exclusive taste of the court; and from the commencement of the 16th century till the appearance of Corneille, scarcely anything was brought forward but either tragedy or that very harmless description of farce which, it was thought, might without much danger be conceded to the popular taste. This is the grand era of the popularity of the well-known burlesque personages *Gros Guillaume, Tabarin,* and *Turlupin*, whose merry reign was protracted even into the age of Louis XIV.

Most of the tragedies of this period flowed from the exhaustless pen of Alexandre Hardy, a poet employed by the company which had succeeded to the privilege of the brethren of the Passion, and who wrote more than eight hundred dramatic pieces, of which forty remain. Possessed of very extensive reading, Hardy made some efforts to deviate from the beaten track of his predecessors: he ventured in some instances to compose what he called tragi-comedies, one of which is founded on a tale of Cervantes; but his genius was not equal to his boldness and facility. The dramatists who immediately preceded Corneille and Molière were Mairet and Tristan, the former of whom, like so many before and after him, tried and failed in the eternal subject of Sophonisba; while the latter failed yet more signally in the Jewish subject of Mariamne.

We now come to the age of Louis XIV., of which Cardinal Richelieu was the real creator in literature, as well as in politics. This great artificer of despotism had the sagacity to perceive that, in order to consolidate his favourite political fabric the more, it was worth while to permanently organise the literary talent of the country in the service of the court. The court, it is true, did not directly dictate to the cardinal's chosen forty in what quarters they should bestow their praise or censure; but things were so ordered that the men to whom the protectorship of letters was officially entrusted should always share more or less the tastes and opinions of the government: by the court it was that they were paid; under the eyes of the court they held their sittings; it was by court intrigue that a vacant chair was to be obtained, and every writer was ambitious of that honour.

Such was the predominant influence under which Corneille began his dramatic career. To enter the academy, he must please the court; and to please the court, he must defer to the literary dictation of the academy. Now, in dramatic composition, the academy not merely recommended adherence to the so-called rules of Aristotle, but prescribed their observance with the greatest rigidity. The tragedy of France became conventional; the structure of the verse, and the opportunities it gave for a studied and correct declamation of passages of poetical beauty and of lofty sentiments, gained the popular ear; and the subtle delineation of character, except in the marked features of love, ambition, or revenge, were neglected, or only displayed in occasional passages by the men of real genius, who, reflecting the feelings of their age, composed their dramas to suit the national taste. Some little romance was introduced from the Spanish school, but curtailed to tameness to fit the Procrustean bed they had chosen. Their productions have been treated of under the heads of CORNEILLE, RACINE, VOLTAIRE, &c., in the BIOG. DIV.

The rise of the French comedy of character, of which Molière is the great representative, is yet more clearly connected with the Spanish source than that of their classic tragedy. But Molière was born for the comic only, and could indulge his dramatic tastes and propensities with comparatively little restraint. In his first pieces, written for a strolling company, he imitated the lively trickery and buffoonery of the Italian farces, a species of composition for which, throughout his career, he showed a strong inclination. [MOLIÈRE, in BIOG. DIV.]

The restrictions which cramped the genius of Corneille comfortably fitted that of Racine, and contributed to render him in every sense the favourite tragic poet of the court of Louis XIV. He seemed born to carry to the highest possible perfection what we must call, for want of a neater term that should be equally appropriate, the Frenchification of Greek tragedy. [RACINE, in BIOG. DIV.]

In the history of French tragedy, it is little gratifying to pass from Racine to Richelieu's favourite, the Abbé D'Aubignac, who revenged himself for the failure of his tragedy of 'Zénobie' by censuring bitterly the works of Corneille. Racine himself found a similar adversary in Nicholas Pradon, who wrote a rival tragedy of 'Phèdre,' which Madame Deshoulières was not ashamed to extol above Racine's, and a 'Régulus,' which the praises of St. Evremond and Madame de Sévigné have not saved from oblivion. Lafosse profited somewhat better by Corneille's example in the dignity and intelligence which he threw into his otherwise feeble 'Manlius.' As for the tragedies of Duché, Campistron, the abbé Pellegrin, the abbé Longepierre, and others, suffice it to say, that they brought little fame to their authors, and no advancement to the art. Thomas Corneille ventured to write tragedy after his brother, and wrote it very "correctly." Crébillon was by far the most successful tragic writer that arose in the interval between Racine and Voltaire; but his reputation was rapidly acquired. [CORNEILLE, THOS., in BIOG. DIV.]

This species of composition occupied no small proportion of the wonderful versatility of Voltaire, who has earned, in universal estimation, a place beside Corneille and Racine as a dramatic artist. [VOLTAIRE, in BIOG. DIV.]

La Harpe, whose critical labours had so extensively injurious an influence throughout Europe in enforcing the classic system in all its rigidity, contributed nothing to recommend it by his own tragic compositions, which, while they are among the most correct in style, are among the most frigid in sentiment and effect. On the other hand, Marie Joseph Chénier, who, flourishing in the early days of the Revolution, wrote, like the tragic poets of Greece, in the midst of free men, and with like ardour stimulated them to the love of liberty, made nearer approaches than any of his predecessors to the tragic strength and fervid diction of Voltaire. His 'Charles the Ninth, or the School for Kings' (École des Rois), was that among his pieces which produced the greatest excitement in the public mind. Ducis, possessing brilliant powers of poetic execution, in his tragedy of 'Albufar' pictured his ideas of Arabian manners with great warmth of imagination and originality of style: but his highest claim to dramatic celebrity rests upon the endeavour which he made to bring his countrymen acquainted with the masterpieces of Shakespere. The name of M. Arnault appears already in the dramatic annals of that period. His first tragedies, 'Marius à Minturnes,' 'Lucrece,' and 'Cincinnatus,' with their energetic simplicity, are in spirit and design a copy of the antique. Gabriel Legouvé's 'Death of Abel' (Mort d'Abel) was a hazardous but successful attempt to make an antediluvian subject acceptable on a modern stage, to which he had been encouraged by the popularity which Gessne, and his poetry then enjoyed. The same author ventured to exhibit, not unsuccessfully, in 'Epicharis et Néron,' the latter days of Nero, the opening of whose career is shown in one of the masterpieces of Racine. 'Les Templiers' of M. Raynouard, founded on the destruction of the order of Knights Templars in the reign of Philippe le Bel, is much more remarkable for art and correctness of structure and execution than for poetic vitality; but these merits, added to the powerful interest of its national subject, made it highly successful.

Some of the comedies of Boursault, a younger contemporary of Molière, have kept possession of the stage: they are all of the secondary description which the French call *pièces à tiroir*, of which Molière himself, in his 'Fâcheux,' gave the first example. This kind, in the accidental nature of the scenes, which are strung together on one common occasion, bear a resemblance to the *mimi* of the ancients: they are particularly favourable for the display of the mimetic art in the more limited signification of the term, as it is one and the same player that re-appears throughout in a fresh character and a different disguise. The want of dramatic movement however in such productions requires they should be short, whereas Boursault's pieces, though otherwise possessing considerable merit, are drawn out to the wearisome length of five acts.

After Molière's death, a considerable time elapsed before the appearance of Regnard, to whom the second place among the French comic writers has usually been assigned. [REGNARD, in BIOG. DIV.]

The 18th century produced a number of comic writers in France of the second and third rank, but no genius capable of advancing that department of the dramatic art a step farther, and thus the belief in the unapproachable excellence of Molière, became yet more firmly fixed.

In the overthrow of the *ancien régime* in politics fell the main support of the old dramatic code; yet it is remarkable, though perhaps not wonderful, that many of the warmest and firmest opponents of the former rule, both then and since, have clung to the classical literary canons; so strong and so binding is the force of habit, especially of literary habit, so long as the analytic powers have not been brought to bear directly and expressly upon the subject in question. The revolution in French art and literature consequently followed but tardily the political revolution; and its first promoters had to contend against the most formidable obstacles. However, they presented themselves early in the field. The stormy days of the Convention, and the saturnalian period of the Directory which followed, did indeed afford little leisure or encouragement for the cultivation of the liberal arts; but no sooner were the danger and the fear of anarchy removed by the firm and vigorous administration of the Consulate, than the new literary and dramatic ideas began to develope themselves, and, in consequence, a violent war to be waged between the *classicistes* of the old school and the *romanticistes* of the new.

Among the earliest, ablest, and steadiest cultivators of the French romantic drama, the first place seems due to M. Népomucène Lemercier. His tragedy of 'Agamemnon' combines felicity of plot, purity of style, and discrimination in depicting characters and manners.

The revolution of 1830 was a victory won for liberty in art as well as in politics. Since then, the higher departments of the French drama, both as to writing and acting, have been in full activity. Among the advocates and emulators of the Shaksperian *drama*, Victor Hugo has hitherto shown himself the foremost, the boldest, and the ablest. In tragedy in the more limited sense, though still of the romantic school, Alexandre Dumas and Alfred de Vigny are the most distinguished. It is the higher comedy that seems at present to be the least flourishing. Meanwhile, the classic reputation of Molière preserves his comedies on the stage, although in tone and manners they are altogether obsolete. But we do not intend to enter upon disquisitions of the merits of contemporaneous writers; we may, however, state that they have been very successful in the minor departments of the dramatic art; and that numerous farces and interludes have a high degree of wit, satire, and ornamental characterisation.

The serious or ideal French opera dates from the time of Louis XIV. Cardinal Mazarin, himself an Italian, had introduced into France the taste for the Italian opera. Louis too was desirous of rivalling or surpassing foreign nations in the external magnificence of the drama—in decoration, machinery, music, and dancing; these were to be used on festival occasions at court, and accordingly Molière was employed to write gay operas, and Quinault grave ones, for the music of Lulli. As Quinault is the only great poetical name in the history of the higher French opera, we refer to the notice of him [QUINAULT, in BIOG. DIV.] for further remarks on that particular species. The *operette*, or comic opera, has been much more successfully cultivated by modern French writers, owing, in a great degree, to the substitution, in this kind, of ordinary dialogue in lieu of recitative, so unfavourable to dramatic animation. The *vaudeville*, in which the lighter dramatic writers of France have of late been so wonderfully prolific, and which so peculiarly harmonises with the tone of good-natured gaiety in the more popular classes of that country, is but a variety of the comic opera; its essential distinction being, that it dispenses with musical composition, as the songs are set to well-known popular airs.

It is a fact worthy of attention, that the histrionic art, especially in tragedy and the higher comedy, has long been carried in France to very high perfection. Schlegel himself admits, that in external dignity, quickness, correctness of memory, and in a wonderful degree of propriety and elegance in the delivery of verse, the best French actors can hardly be surpassed.

German Drama.—The earliest mention of the performance of Mysteries in Germany appears in the 'Eulen-spiegel,' which professes to be the history of a celebrated buffoon of that name, who is stated to have lived about the middle of the 14th century, although the book itself is not older than the beginning of the 15th. We there find, amongst other elegant matters, "How Eulen-spiegel made a play in Easter fair, wherein the priest and his maid-servant fought with the boors." The oldest extant German drama was written about the middle of the 15th century, by one Hans Rosenpluet, a native of Nürnberg. He was succeeded by two fertile writers born in the same imperial city, Hans Sachs and Ayrer. Among the works of Hans Sachs we find a great number of tragedies, comedies, and spiritual and temporal histories, where the prologue and epilogue are always spoken by the herald, besides merry carnival plays: but Tieck observes that they can scarcely be reckoned as dramatic works; they are either religious or secular tales or novels, related in dialogue. All these pieces, it appears, were acted, not by players, but by respectable citizens, as an allowable relaxation, without any theatrical apparatus. The carnival plays are rather coarse, but often extremely droll, running indeed into the wildest farce, and overleaping all the bounds of reality. Ayrer, who lived at the latter end of the 16th century, among his numerous pieces, introduced many imitations or adaptations of the English drama; and during his time companies of English actors performed in various parts of Germany, particularly at Dresden.

In the first half of the 17th century, Opiz, regarded as the founder of the modern forms of German poetry, translated several tragedies from the ancients into verse, and composed operatic pastorals after the Italian manner; but it is not known whether he wrote anything expressly for the stage. Next came Andreas Gryphius, considered as the first dramatic writer of Germany. Among his imitations and translations from various modern languages, are, a tragedy from the Flemish of Vondel, and a farce called 'Peter Squenz' (Peter Quince), which is an extension of the burlesque tragedy of Pyramus and Thisbe in Shakspere's 'Midsummer Night's Dream.' But the intimacy of the Germans with the English drama seems to have suddenly ceased about this time. Gottsched, who wrote a good deal for the stage, introduced imitations and adaptations from the French on the classical model, that is, adhering to the unities; and though this was opposed by Bodmer, and some other critics, it was for a time successful. Gottsched and his players solemnly buried the German 'Hanswurst' (the clown), and Gellert and Weisse followed in his footsteps. Thus, bad translations of French plays, with pieces from Holberg, and afterwards from Goldoni, and with some feeble German imitations devoid of any peculiar spirit, may be said to have constituted the repertory of the German stage, until Lessing appeared to commence the work of redeeming it from its long-continued mediocrity.

The sceptical and analytic spirit of Lessing was, however, more successful in reforming the theory than improving the practice of the German drama. [LESSING, in BIOG. DIV.] The boldness and acuteness with which, through this medium, he attacked the prevalent French taste in tragedy were so successful, that in a short time not only the translations of French tragedies, but the German tragedies modelled after them, disappeared from the stage. He was the first in Germany who contended for the claims of Shakspere to be considered as a real and great artist, and by intelligent criticism established the study of him in his fatherland. The reform introduced by Lessing paved the way for GÖTHE and SCHILLER [BIOG. DIV.]: their success produced swarms of imitators, Iffland with his vapid comedy, Kotzebue with his sentimentality (of whose plays some have obtained a place on the English stage), and others. The great support, however, of the drama of character is the marked popularity of Shakspere, assisted as it has been by the admirable translations of Schlegel, Tieck, and others; while the French theatre supplies the afterpieces, the farces, and the operettas.

The example, however, of Göthe and Schiller, together with the admiration of Shakspere, has continually induced writers to try their strength in this field. Tieck ('Dramaturgische Blätter,' vol. i.), after commenting on the French mode of repudiating from tragedy all trivial circumstances, all reality, all national subjects, as too unideal; says, "When Shakspere first became popular in Germany, many struck out in an entirely opposite direction. They could never heap up sufficient casual circumstances, however mean, which, with all the anecdotes and speeches that they could find, they packed in all their rudeness into their tragedies, and this proceeding they styled nature." Of this school the best is G. A. von Kleist, who sinned chiefly in this assembling of trivialities, for some of his pieces, as 'Katherine of Heilbronn,' and the 'Hermannschlacht,' in other respects have considerable power. Other names are Arnim, Müllner, Halm, Theodor Körner, and Gutzkow. Arnim belonged to the romantic school, but was more successful in his novels than his dramas. Müllner was a classicist of the French school, and a copious and fluent writer. He translated, or adapted considerably, from the authors of that country, and had himself something of the light wit and invention which characterise them. In his 'Albaneserin,' a tragedy in which he endeavoured to work out a plot based on the Greek doctrine of destiny, he has violated all probability and consistency of character in working it out, but it became very popular on the public stage. F. Halm (the pseudonym of Baron E. F. J. Münch-Bellinghausen) was of the romantic school, but his 'Griselda,' and 'Imelda Lambertazzi,' were not very successful; nor were his translations or adaptations from the Spanish drama. T. A. Körner, about 1811, wrote a number of dramatic pieces; the most noticeable were 'Zriny,' founded on the events in the life of the hero of Hungary; and 'Rosamunda,' wife of Alboin the king of the Lombards; which showed considerable promise, though combined with marks of immaturity and carelessness. Gutzkow's 'Richard Savage' is a tragedy of the domestic order; it has good passages, but little of dramatic characterisation. His comedies were better, and his 'Zopf und Schwert,' and the 'Urbild des Tartuffe,' were deservedly popular. It is remarkable that Tieck, in the work above quoted, written about 1818, mentions no modern dramatist with anything more than faint praise. Grillparzer, in his 'Ahnfrau,' and a few other pieces, has displayed a high poetic talent, with considerable dramatic power, but rather in situations than in delineation of character, though this is not altogether wanting. Except by Grillparzer, whom the Germans themselves reckon as their best dramatist since Schiller, the German tragic muse has produced nothing worthy of especial notice. Of the German opera this is hardly the place to speak, though in this they have excelled, as the names of Mozart, Beethoven, Spohr, and Meyerbeer, who are noticed in the BIOG. DIV., are sufficient evidence.

English Drama.—The period in which we find the earliest traces of the general introduction of dramatic exhibitions by the clergy throughout the spiritual empire of Rome, being that in which, under the regime of the Norman conquest, the old French language and literature had full predominance in England, and a very large proportion of its clergy were of Gallic extraction, French was necessarily the original language of our religious drama: and the first pieces that it possessed were either borrowed directly from continental writers, or were composed by the Anglo-Norman clerks in the Gallic idiom. None of the dramatic manuscripts in that language, which must have been used in England for two or three centuries after the conquest, have descended to us; but in addition to the most sufficient historical evidence of the fact, some of the miracle plays that remain in English contain the plainest internal evidence of their having been closely translated from a French original. It was not until the 36th of Edward III. that the pleadings in any of the courts of law were allowed to be made in English. At the commencement of Edward's reign (as observed by Tyrwhitt in the essay on the language and versification of Chaucer, prefixed to his edition of the 'Canterbury Tales') the French and English languages subsisted together throughout the kingdom; the higher orders, both clergy and laity, speaking almost universally French; while the lower retained the use of their native tongue, but also frequently added to it some knowledge of the other. Ralph Higden himself, the reputed author of the Chester miracle-plays as they now appear in English, bears a remarkable testimony (in his 'Polycronicon,' b. i., c. lix.) to the manner in which the English language was impaired by the children in general being still obliged at school to construe their lessons, &c. in French, by the children of the gentry being taught to speak French from their cradle, and by the anxiety of the commoners to talk French that they might be the more highly thought of.

We find religious dramas to have been regularly established performances in London as early as 1180. William Fitzstephen, in the introduction to his Life of his friend and patron, archbishop Becket, written between 1176 and 1182, tells us that London, in lieu of the theatrical spectacles and stage plays of the Romans, to which he had just before alluded, had then a holier description of plays, in the representations of the miracles worked by holy confessors, or of the sufferings wherein the martyrs had displayed their constancy. However, from Mathew Paris ('Vitæ Abbatum') and from Bulæus ('Historia Universitatis Parisiensis') we learn that the miracle-play of 'St. Katherine' had been exhibited at Dunstable before the year 1119. According to the latter authority this play of 'St. Katherine' was not then by any means a novelty; and from a passage in the 'Annales Burtonenses,' or 'Annals of Burton Abbey,' we may infer that in the middle of the 13th century itinerant actors were well known in England.

The oldest extant specimen of a miracle-play in English is among the Harleian MSS. in the British Museum: it probably formed one of a series, and is certainly as ancient as the earlier part of the reign of Edward III.; it is founded on the 16th chapter of the apocryphal gospel of 'Nicodemus,' and relates to the descent of Christ into hell, to liberate from thence Adam, Eve, John the Baptist, and the prophets. Besides this and a few other single pieces, and a set of three plays founded on that part of the 'Acts of the Apostles' which relates to the conversion of St. Paul, there exist in this country three series of miracle-plays which go through the principal incidents of the Old and New Testaments. These are: 1. The Towneley collection, supposed to have belonged to Widkirk Abbey, the MS. of which appears to have been written about the reign of Henry VI. 2. A volume called the 'Ludus Coventriæ,' consisting of plays said to have been represented at Coventry at the festival of Corpus Christi, the MS. of which is at least as old as the reign of Henry VII. 3. The Chester Whitsun plays, of which there are two MSS. in the British Museum, one dated in 1600, the other in 1607. Several specimens of Cornish miracle-plays are extant, which differ from the English in no material characteristic but that of language.

There is abundant evidence that the Romish ecclesiastics, in their first introduction of this kind of representations, especially that part of them relating to the birth, passion, and resurrection of Christ, had the perfectly serious intention of strengthening the faith of the multitude in the fundamental doctrines of their church; and it seems the less extraordinary that they should have resorted to this expedient, when we reflect that before the invention of printing, books had no existence for the people at large. But it is no less certain that the repetition of these exhibitions rapidly worked upon the popular mind an effect which it is likely, the priestly dramatists themselves had not contemplated in the first instance: it developed the universally latent passion in the breast of social man for spectacle in general, and for dramatic spectacle especially, *for its own sake*. Here, again, was the strongest encouragement of all for the clergy to persevere in their dramatic efforts. Finding the lively pleasure which the people took in this mode of receiving religious instruction, they were tempted to add, according to their barbarous ability, embellishment after embellishment to the simple copies which they had originally presented of the most remarkable passages of Scripture story, until the profane exhibition itself, "the miracle *play*," and not the sacred subject of it became the sole object of interest to the people who composed the audience at these representations, as, also, it became the primary object of the greater part of the ecclesiastics who took part in getting them up. These two facts are shown with the utmost clearness by the collective testimony of all the contemporary writers who have thrown a general light upon the manners of the later middle ages.

The dialogue in these productions was, for the most part, extremely rude and inartificial; and as to plot, they cannot properly be said to have had any. It is not until the middle of the 16th century that we arrive at a scriptural play having anything approaching to a regular constructed dramatic action. In this respect the series of plays which we have been considering should rather be described as a series of shows or pageants exhibited in succession, but without any artificial connection. Each of these detached divisions of the representation was indeed commonly called a "pageant;" and each succeeding play or pageant of the series was supported by a new set of performers. Thus, to get up one of these extensive sets of plays, it was necessary to provide and to prepare a large number of actors; and here we see one manifest reason why this longer class of performance was almost wholly confined, in England as well as on the continent, to the larger cities.

The seasons for exhibiting the grand scriptural plays were chiefly the Christmas and Whitsun holidays. The getting up and acting of these in the great cities early devolved upon the trading companies each guild undertaking a portion of the performance and sustaining a share of the expense. The authentic information regarding the exhibition of the Corpus Christi plays at Coventry extends from the year 1416 to 1591, during the whole of which period there is no indication that the clergy in any way co-operated. The Chester records likewise establish that the whole management of these representations there was in the hands of laymen. From Stow's 'Chronicle' we learn that in London this class of performances was undertaken by the parish clerks (who were incorporated by Henry III.) as early as 1409; and it is remarkable that no instance is to be found of the trading companies of London having been, at any date, so engaged. The pieces were acted on temporary erections of timber, called scaffolds or stages; and it appears that in some instances they were placed upon wheels, in order that they might be removed from one part to another of a large town, and so the plays might be repeated successively in various quarters. Some of the Chester pieces required the employment of two, and even of three scaffolds, besides other contrivances: the street also must have been used, as several of the characters enter and go out on horseback. The same remark is applicable both to the Widkirk and the Coventry plays. In the latter indeed "the place" and "the mid place" are mentioned as the scene of part of the action; and it is evident from some of the stage directions, that two, three, and even four scaffolds, were erected round a centre, the performers proceeding, as occasion required, from one stage to another across "the mid place." It may be observed, too, that in one of the Widkirk plays Cain is exhibited at plough with a team of horses; and that in another it is absolutely necessary that something like the interior of a cottage should be represented, with a peasant's wife in bed, who pretends to have been just delivered of a child, which lies beside her in a cradle.

Miracle plays were acted very constantly at Chester until 1577, at Coventry until 1591, at York until late in the 16th century, at Newcastle until 1598, at Lancaster, Preston, and last of all at Kendal, in the beginning of the reign of James I. Although, in the beginning, these plays only dramatised certain scriptural events by the characters historically concerned, yet abstract impersonations found their way into them by degrees. This was perhaps done to introduce some variety into the constant repetition of the same sets of *dramatis personæ*.

Among the first innovations of this kind were the representatives of Truth, Justice, Peace, and Mercy, in the 'Parliament of Heaven,' which forms part of the eleventh play or pageant of the 'Ludus Coventriæ.' Death, in the same series, was a subsequent addition; and the Mother of Death, a still later enrichment; until at length such characters as 'Renfin' and 'Lyon' were employed, having more of individuality, but still personifying the passions supposed to have actuated the Jews against Christ. As such characters became more numerous, they interfered in a certain degree with the progress of the action; in some pieces the scriptural characters fell quite into the background; and thus, in course of time, what seems to have been at first designed as a sort of poetical embellishment to an historical drama, became a new species of drama, unconnected with history. This was called a "moral" or "moral-play," the object being to enforce and illustrate some ethical precept; for it must be observed, that the term "morality," as applied to a dramatic production, is, like "mystery," of comparatively recent introduction into our language. Some manuscript productions of this class show that moral plays were in a state of considerable advancement early in the reign of Henry VI. They seem to have reached their highest perfection under Henry VII., although they afterwards exhibited a greater degree of ingenious complication. In the reigns of Henry VII. and VIII., a company of actors usually consisted of only four or five individuals; but by doubling some of the parts, they were able to perform the greater number of the dramatic entertainments then in fashion.

Besides allegorical personages, there are two standing characters very prominent in moral-plays, the Devil and the Vice. The Devil was no doubt introduced into moral-plays from the old miracle-plays, where he had figured so amusingly that his presence was indispensable in the new species of drama. As for the Vice himself, his name appears to have been derived from the predominant nature of his character, as amidst all his varieties of form, he is constantly represented as most wicked in design.

The mechanical contrivances used for the representation of moral-plays differed in no material point from those employed in the religious exhibitions, which they gradually superseded; except that, in general, there seems to have been only one scaffold or stage, which was erected either in a street or on a green adjoining a town or village, sometimes in the public hall of a city or borough, and sometimes in a great private mansion. As an example of something between the old moralities and the later interludes of manners may be cited the "goodly interlude and merry" of John Skelton, whom Dyce regards "as one of the fathers of the English drama." In this interlude, which is entitled 'Magnificence,' and which is printed in Skelton's works (Dyce's ed. i. 225, &c.), the characters are Felicity, Liberty, Measure, Magnificence, Folly, Adversity, Despair, &c., eighteen in all, and all allegorical. Skelton also wrote two other "moral interludes," 'Nigromansir' and 'Virtue,' and what he himself in his 'Garland of Laurel' speaks of as "His comedy, Achademios called by name," but neither of these is known to exist.

The performance of moral-plays was not wholly discontinued until the end of Elizabeth's reign; and one of the last dramatic representations that she witnessed was a piece of this kind, 'The Contention between Liberality and Prodigality,' played before her in the 43rd year of her reign. Attempts had however been very early made to invest even symbolical representatives with metaphysical as well as physical peculiarities, and attract for them a personal interest; and thus it was that even in the allegorical species, the nature of which would seem to have least admitted of such modification, advances more and more decided were successively made towards individuality of character, and consequently towards the representation of actual life. Hence nearly all the later moral-plays exhibit a strange mixture of individual characters with allegorical impersonations, which, however, with all its violent incongruity, was a necessary step in the progress towards the modern drama, the drama of human passions and manners.

The first English dramatic productions in which it was attempted to exhibit sketches from actual life without any scriptural, saintly, or allegorical intermixture, belong to that class to which the denomination of *interludes*, though it has had a more general application, most properly and distinctively belongs. These pieces being, as their name imports, expressly designed for performance during the intervals of convivial entertainment, the first condition of their structure was, that the limits should be brief and the characters few. John Heywood, a musician of the households of Henry VIII. and Queen Mary, set the first example of composing interludes quite independently of allegorical materials. [HEYWOOD, JOHN, in BIOG. DIV.] He was essentially undramatic, and his humour is coarse.

The only extant English interlude from real life in which the tragic element predominates, was designed, its title tells us, to show "as well the beauty and good properties of women, as their vices and evil conditions," contrasting the character of the heroine Melibea with that of Celestina, a sort of compound of procuress and sorceress, who is hired by Melibea's lover to corrupt her, in which, after using extreme art, she succeeds; and the piece ends with exhibiting the bitter grief and repentance of the heroine. It is founded on the famous Spanish 'Celestina,' which we have already described as a long dramatic dialogue rather than a drama; but though the English piece has some vigour, it altogether wants those subtle graces which gave so wide a popularity to its foreign prototype.

'A newe, mery, and wittie comedie or enterlude, treating upon the historie of Jacob and Esau' (apparently written about 1557, but not printed till 1568), though its subject is scriptural, makes nearer advances to the structure and general character of a modern play than any piece that preceded it. In addition to the scriptural characters, it has, of the author's invention, Ragau, servant to Esau; Mido, a boy who leads blind Isaac; Hanon and Zethar, two of Isaac's neighbours; Abra, a girl who assists Rebecca; and Debora, an old nurse. Here indeed we have a five-act play, with a plot regularly constructed, characters discriminated and contrasted, and a versification, for that period, vigorous and flowing, while the comic portions of the piece have humour independent of coarseness.

The general tenor of the last-mentioned play is tragic, or at least decidedly serious. In the earliest piece of equal dimensions and regularity of structure that can properly be termed a comedy, we have also the first avowed dramatic imitation, in English, of the ancients. This is 'Ralph Roister Doister,' which was certainly in being as early as 1551, and probably written as early as the reign of Henry VIII. The former existence of such a piece had long been known, when in 1818 a printed copy was discovered, of which a limited reprint has been made. The author was Nicholas Udall. [UDALL, in BIOG. DIV.]

Another comedy, of the like dimensions and general structure, is entitled 'Misogonus;' and the author was apparently one Thomas Rychardes. The scene is laid in Italy, and the piece was probably founded on some Italian tale or play; it represents, however, the manners of England, and has many allusions to the circumstances of the day: although the plot is simple, there is much variety of situation and character; and it is worthy of remark that, under the name of *Cacurgus*, the qualities and functions of that important personage, the domestic fool, are more distinctly as well as amusingly exhibited than in almost any other of our old plays. This piece is ascertained to have been composed about 1560. It is certain that the former of these two comedies, and extremely probable that the latter, preceded the production of 'Gammer Gurton's Needle,' which all our literary and dramatic antiquaries before Mr. Collier have spoken of as the earliest English comedy, though, when it was acted at Christ's College, Cambridge, in 1566, its author, Still, afterwards bishop of Bath and Wells, was only in his twenty-third year. This however appears to be the first existing English play that was acted at either university; and it is a singular coincidence that its author should have been the very person who, many years after, when become vice-chancellor of Cambridge, was called upon to remonstrate with Queen Elizabeth's ministers against the having an English play performed before her at that university, as unbefitting its learning, dignity, and character.

The earliest extant piece in English that can now with any propriety be termed a tragedy, was written by Thomas Sackville (afterwards Lord Buckhurst and Earl of Dorset) and Thomas Norton, a barrister; and was acted before the queen at Whitehall, on the 18th of January, 1561. In the first and third printed editions it is called 'The Tragedy of Gorboduc,' from the name of a supposed ancient British king; but in the second it is entitled, more correctly, 'The Tragedy of Ferrex and Porrex,' from those of his two sons, who contend for sole possession of his kingdom after he has divided it between them. This tragedy was followed almost immediately by 'Julius Cæsar,' the earliest instance on record in which events from the Roman history were dramatised in English, although the precise nature of this performance, of which we have nothing but the mention in an old manuscript chronicle, cannot be ascertained. It is doubtful, however, whether both these pieces were not preceded by a tragedy founded on Luigi da Porto's famous tale of 'Romeo and Juliet.' From about this date until shortly after 1570, the dramatic field seems to have been pretty equally divided between the later moral-plays and the earlier attempts in tragedy, comedy and history. In some pieces of this date and a little later, as already shown, endeavours were made to reconcile or combine the two kinds of composition; but afterwards the morals generally gave way to the more popular and intelligible species of performance. We find precedence given to the latter in the licence to James Burbage and others in 1574, in its mention of "comedies, tragedies, interludes, and stage-plays;" and in the act of common council of the following year against theatrical performances in the city they are designated as "interludes, tragedies, comedies, and shows."

Still the terms tragedy and comedy, in general acceptation, remained far from the strictness of signification attached to them by the professed inculcators, by example or precept, of the imitation of the ancients. But comedy was from the beginning used in a more comprehensive sense than tragedy, being in fact very often employed as synonymous with the general designation of play. Hence it is, that Shakspere makes Hamlet, after he has had the tragedy exhibited before the king and queen, exclaim,

> "For if the king like not the comedy," &c.

The vast variety of matters embraced by the dramatists of that day and of sources from which they drew, is perfectly expressed in the prologue to the 'Royal King and Loyal Subject,' one of the earlier productions of Thomas Heywood, who became a writer for the stage some years before the death of Elizabeth; who produced, it is said, two hundred and twenty dramas; and to whom Charles Lamb gave the title of a "prose Shakspere," saying his scenes are as natural and affecting, but we miss the poet.

We have now traced the progress of the English stage from its ecclesiastical and religious origin until it became almost exclusively a mirror of actual life, and attained all those dramatic and theatrical forms which most prominently characterised the later and fuller maturity of our elder modern drama. It was in the same year, 1583, wherein Sidney wrote his 'Apology,' that Elizabeth first allowed a public company to act under her name and authority. As the dramatic writers who flourished in the brief interval between this period and that of the fullest development of Shakspere's genius, with one exception, did nothing importantly to alter or improve dramatic art, it is needless to enlarge upon their various kinds and degrees of merit which made a number of them, as Dekker, Kyd, Lodge, Greene, Lyly, Peele, Nash, Chettle, Munday, Wilson, &c., highly popular and celebrated in their own time. All who have acquired a permanent reputation will be found under their respective names in the BIOG. DIV. The single exception that we are called upon to make is in favour of Christopher Marlow, of whom we must observe, not only that his works exhibit greater vigour both of conception and of language than belongs to any of his contemporaries, but also that he was the first who established the use of blank verse upon the *public* stage, in lieu of that exclusive rhyming which possessed it before he wrote.

Of SHAKSPERE it is not necessary here to speak. A full notice of him is contained in the BIOG. DIV., besides the numerous works entirely devoted to him. Of his younger contemporaries and competitors few have transmitted a living memorial of their works to posterity; the principal are Ben Jonson, and Massinger, who are also noticed in the BIOG. DIV.; as are also Beaumont and Fletcher, who, after Shakspere, are entitled to the highest place among the romantic dramatists of England. They seem indeed to have had almost every dramatic quality short of that marvellously unerring instinct which Shakspere possessed, and which appears to be vouchsafed to few. Webster, Middleton, Marston, Massinger, Shirley, Ford, and such other of the younger contemporaries of Shakspere as we have not yet mentioned, have no characteristics sufficiently distinctive to admit of their being particularised in this general survey, though they are likewise given in the BIOG. DIV.

Such was the general condition of the stage during the reign of Charles I. down to the year 1642, when the invectives of the puritans, who had long murmured against the theatre, and at last thundered loudly against it, were changed into prohibitory law; and in 1648 not only to act plays, but even to witness them, was made a penal offence. Nearly all the players now took arms on that side the interests of which seemed identified with the existence of their own profession. Many of them perished in the field; and after the final close of the war, one company of actors only was formed out of the remains of all the former ones, and occasionally, with great circumspection, performed at private mansions in the vicinity of London.

Davenant as manager, and Betterton as actor, form a slender link of connection between the old stage and that of the Restoration. Charles II. being considered, in his relation to the theatre, as a sort of restoring and tutelar deity, its character was now formed in absolute deference to the half foreign and wholly vicious taste of himself and his courtiers. Under these auspices, Davenant introduced the Italian system of decoration, the *costume* as then understood, the opera music, and the use of the orchestra in general. A still more important innovation in theatrical arrangements was, the permanent adoption of the practice, against which the puritans had directed the most violent of their anti-dramatic fury, but which had long been established in Italy, Spain, and France, of having the female parts personated by women instead of boys. The result of this great neglect of the old dramatic and theatrical system of England, and assiduous study of that of France, was, for a long period, an almost entire denationalisation, both in form and spirit, of the current dramatic literature. Davenant himself, who had resided very much in Paris, seems to have acquired this exotic taste long before the Restoration, as it is fully exhibited, amongst others of his productions, in his operatic piece, 'The Siege of Rhodes,' performed as early as 1656. Hence, in the theatrical restoration which accompanied the political, he set himself cordially to work, by altering old pieces, and writing new plays, operas, prologues, &c., to contribute towards the furnishing of that new theatrical repertory which the new dramatic system required. Of all his works, however, nothing has escaped a merited oblivion.

It was left for the industry and fertility of Dryden to give the new theatre a thorough establishment according to the new ideas, a task to which he applied himself with all possible diligence both by example and precept. [DRYDEN, in BIOG. DIV.] The drama hence became a compound of the extreme licence of the later writers of the early English school, with the conventionality of the French, but without the vigour of the one or the vivacity of the other. The Duke of Buckingham, who, amongst other vigorous though wayward and generally misapplied talents, possessed high powers of ridicule, undertook to satirise these faults and absurdities of Dryden and his school, in his comedy of 'The Rehearsal,' wherein, although the structure of the piece itself might have been more artificial and diversified, the separate parodies are very ingenious and effective.

But the best-aimed satire, though it might correct in some degree could not regenerate the stage. This could have been done only by the arising of some greater and more genuine dramatic genius, or at least by the successful appearance of some very great actor, capable of entering fully into the spirit of the elder drama. 'The Rehearsal' might indeed contribute to produce that nearer approach to nature which, among the compositions of Dryden's younger contemporaries, has preserved upon the stage one tragedy of Lee's and two of Otway's. Shadwell's seventeen comedies, though he affected to imitate Ben Jonson in exhibiting humorous and eccentric peculiarities of character, are deservedly forgotten. Wycherley, so much in favour both with Buckingham and King Charles, and afterwards with King James, had much more genuine pretensions to the higher and more vigorous order of comic power [WYCHERLEY, in BIOG. DIV.], and Congreve deserves to be considered as the true father of "genteel comedy" on the English stage, and was long regarded as the great model for imitation in that department. [CONGREVE, in BIOG. DIV.] All these writers, however, are objectionable for their licentiousness, which, though the representation may have been a correct picture of the manners of the time, very soon banished them from general exhibition or reading.

The continuance of this moral depravation of the drama produced at length, in 1698, a severe castigation from the pen of the sturdy nonjuror, Jeremy Collier, under the title of 'A short View of the Immorality and Profaneness of the English Stage, together with the Sense of Antiquity on this Argument.' In this work, its author, armed with sufficient learning and sarcastic wit, attacked all the living dramatists from Dryden to D'Urfey; and although some of them, including Congreve, less candid on this occasion than Dryden himself, set up a petulant and sophistical defence, yet this publication of Collier's had a permanent effect on the stage as well as on the public mind. This effect, however, was operated only by degrees. Vanbrugh followed in the line of Congreve, and, in spite of Collier's animadversions, did so with little more regard either to morality or decorum, though mingling more humour with his wit. His contemporary, Farquhar, though displaying sufficient libertinism of language and sentiment, did not carry them to so gross an excess. The Restoration period of English theatrical history had not only brought female performers for the first time before the public, but female dramatists also. The numerous comedies of Mrs. Behn, who wrote under Charles II., are remarkable only for the full share which they possess of the licentiousness of her time. But in Mrs. Centlivre, a prolific writer of comedy, exactly contemporary with Farquhar, we find more genuine dramatic talent, yet exhibited much more in a lively bustle of intrigue than in forcible delineation of character. Just at the same period, also, Steele, among the other various exertions of his pen, wrote for the stage in a kindred spirit with Farquhar, but with inferior dramatic skill; and Cibber produced his best comedies, 'The Careless Husband,' and 'The Nonjuror.' Fielding, the novelist, commenced his literary career as a writer of comedy; he chiefly demands notice in dramatic history as one of the principal of those writers for the stage who afforded Sir Robert Walpole a pretext for obtaining the act to limit the number of theatres, and subject dramatic performances to the lord chamberlain's license. In a very similar predicament was Gay, after the appearance, in 1727, of his 'Beggars' Opera.' Its professed object was, by way of burlesque, to ridicule the Italian Opera, which had been established and maintained at great expense, and was thought by many to be rising in hurtful rivalry with the national drama. But amidst the general satire on political and fashionable selfishness and depravity which this composition implied, the persons then in power took so much of it to themselves, that while 'The Beggars' Opera' had the unprecedented run of sixty-three successive nights, and transformed the actress who represented the heroine into a duchess, the lord chamberlain refused to license for performance a second part of it entitled 'Polly. This celebrated production, however, though still a standing favourite with the public, is now chiefly remarkable in dramatic history as the prototype (unwittingly, it seems, on its author's part) of a new species of dramatic composition upon the British stage, since known as 'the English opera.'

We must now revert for a moment to the history of modern English tragedy. After the example of Lee and Otway, Southern and Rowe endeavoured to return to a more natural tragic tone and style than those which Dryden had so long practised and inculcated. Addison's 'Cato,' notwithstanding the great temporary celebrity and popularity which party rivalry conferred upon it, merits no attention in the history of dramatic art, except as having been the first, and, it should seem, the model, of a series of the most frigid productions in imitation of the French classic school, by Young, Johnson, Thomson, Glover, &c., that are to be found in our literary history. With some small poetic, they have no dramatic pretensions; yet the very excess of their formality and frigidity perhaps contributed to that decisive reaction of the public mind in favour of the elder dramatic school, which took place in the middle of the last century, and which now demands our attention.

Garrick's restoration of Shakspere to his rightful supremacy over the English theatre was a combination, upon a more extensive scale, of the efforts in the same direction which had been made by Betterton. The success of Garrick contributed much to that more general appreciation of Shakspere which gradually went on increasing. This appreciation, which was not a mere passing fashion, was nothing less than the removal of one great mark, worn for eighty years before, of national degradation, morally and intellectually. Had any such actor as Garrick existed at the restoraton of Charles II., he might probably have done much to prevent the wretched denationalisation of the theatre which was so much favoured by that king's exotic and vitiated taste.

Garrick himself, having made no great attempt in dramatic composition, exposed himself to no considerable failure: one or two of his small afterpieces have kept possession of the stage; but his labour of this kind most worthy of mention is probably the share which he took in the composition of one of Colman's best comedies, 'The Clandestine Marriage.' Cumberland's comic powers were respectable; but in his most successful pieces, 'The West Indian,' brought out by Garrick in 1771, and 'The Wheel of Fortune,' to which John Kemble's masterly personation of the principal character gave so decided a popularity, he scarcely rises above mediocrity. Horace Walpole's tragedy, 'The Mysterious Mother,' though its subject necessarily excluded it from representation, set the first example of a vigorous attempt to return to a natural and healthy tragic tone and style. As for the 'Douglas' of Home, it has no such qualities to recommend it, but acquired and has retained the public favour chiefly by dint of one truly and deeply pathetic situation wherein the strongest domestic affections are profoundly and permanently interested. Sheridan gave new life and spirit to "genteel comedy," in which department he remains at the head of the writers of the present era. Though perhaps his pieces are less perfectly finished than those of Congreve, already characterised as the chief of this class of dramatists in the preceding period, and although, especially in 'The School for Scandal,' he is subject to the same imputation as his predecessor, of being too indiscriminately lavish of epigrammatic wit, yet he has more truly comic wit, more force of genuine humour, than Congreve, as is more particularly felt in his play of 'The Rivals,' and should therefore, we conceive, be ranked above him as regards the more essential qualities of comedy. The dramatic merits of Goldsmith were of a totally different cast: a certain eccentric drollery of character and whimsical extravagance of plot are the distinctive characteristics of his two comedies, one of which, though by no means among the most excellent productions of his pen, has kept an honourable place in the public favour. Of the elder Colman's pieces, two, 'The Jealous Wife' and 'The Clandestine Marriage,' are still deservedly esteemed; and the latter in particular is frequently acted: they combine much elegance of composition with considerable comic power. Nor among the comic dramatists of the latter half of the last century must we forget to mention the once celebrated Samuel Foote, who has been more commonly than appropriately called the English Aristophanes, seeing that such a designation conveys much too high a compliment to Foote, and a very indifferent one to the great master of the elder Grecian comedy. So little had Foote's pieces of that burlesque ideality which constituted the essential character of the latter, that his exercise of the *vis comica* reduced itself almost exclusively to a contemporary personal satire, amounting to little more than a refined species of mimicry, which, from the merest mercenary motives, he directed quite as readily against the most innocent peculiarities of living individuals as against the most injurious vices or follies. Hence it is, that of the many farces which he wrote, chiefly to exhibit in them his own powers of satirical mimicry as an actor, not more than one survives upon the stage.

It was towards the close of the century that the sentimental comedy of the German school of Kotzebue, with little but its novelty to recommend it, acquired a footing in England. In this kind, among the direct adaptations from the German, 'The Stranger' has had the most general success, and is the most perfect representative of the species. Among the native efforts in the same line, Holcroft's 'Road to Ruin' is still popular. The same writer has the credit also of having first introduced on the English stage the melo-drama, which has since filled so large a place upon it. Mrs. Inchbald, among many pleasing original pieces in the lighter comedy, has likewise given us an adaptation from Kotzebue. Tobin's 'Honeymoon' still holds possession of the stage. Morton, with too much of the German sentimentality has considerable humour, and sketches character and manners with frequent success. Kenny and O'Keefe also produced a few comedies and farces of more than average merit. M. G. Lewis, in his tragedies, as in his romances, drew from a very different German source, in his taste, we might almost say his rage, for the marvellous and the terrific. A kindred spirit is displayed in the late Charles Maturin's tragedy of 'Bertram.' As regards Lord Byron's tragedies, we have only to remind the reader that as their author never designed them for representation, he is by no means chargeable with their dramatic failure.

We abstain from individual criticism of living English contemporaries. As regards modern efforts in the Shaksperian drama, the flight in this case is so lofty and so bold, that even to attempt it may be said to require almost as vigorous and as rare a genius as to succeed. But on the ground next in elevation, that of tragedy in the more limited sense, aspirants, if not very numerous, are still, from time to time, presenting themselves: however, we have not yet anything that approaches in natural vigour or in poetic richness, either to the master-pieces of Schiller, or even to the most successful efforts of the new romantic school of France. In the higher comedy the experiments are yet more rare. Decency has long been thoroughly established in this department; but since Sheridan's time, we have very few comedies in which we may look for the raciness of humour, the brilliancy of wit, or the happiness of invention which seasoned the licentiousness of our earlier comic writers. Of the occasional pieces written to show off the talent of particular actors, the numerous adaptations of French farces and vaudevilles, and the many trifles that are continually coming forth into an ephemeral popularity in the form of comic opera or burletta, we shall merely remark that, with much that is lively and amusing, they have little that indicates either vigour or originality of dramatic talent.

DRAMATIC LITERARY PROPERTY. [Copyright.]

DRASTICS. [Cathartics.]

DRAWBACK, in commerce, is a term used to signify the sum paid back by government on the re-exportation of goods, upon the importation of which an equal sum has already been paid as duty. The object of this repayment is to enable the exporter to sell his goods in foreign markets unburdened with duties; and it is clear that if duties are required to be paid on the first importation, no transit trade can be possibly carried on unless drawback is allowed by the government. Payments of this nature, although they are sometimes confounded with bounties, are in principle essentially different from them. [Bounty.] Previous to the establishing of the warehousing system in this country in 1803, and when the payment of duties on all foreign and colonial merchandise, with the exception of tobacco and East India goods, was required on the first importation, drawbacks were in all cases allowed upon re-exportation. This course was injurious, not only to trade, but also to the revenue. Goods may now be warehoused, and the duty is only paid when withdrawn for home consumption; but drawbacks are allowed on articles, such as paper whether printed or plain, which have paid an excise duty.

DRAWBRIDGE is a moveable description of bridge used in ancient castles and in modern fortresses, the object being to obtain a secure means of communication across a river, canal, or ditch, with the means of cutting off that communication when necessary, in order to prevent the enemy using it to gain access to the place, and in the two former instances to permit the passage of vessels. Drawbridges are ordinarily of one of the three following kinds: 1. Bascule, Balance, or Lifting; 2. Turning or Swivel; 3. Rolling.

The first is the description of drawbridge that was commonly used in old castles and fortresses, and in its simplest form consists of a platform turning on a pivot or hinge in the escarp wall, and raised by means of chains attached to the other end of the bridge, passing over pulleys in the archway which gives access to the bridge.

The swivel or turning bridge may be formed in either one or two leaves, each leaf turning horizontally on a pivot firmly fixed in the bank, on which it rests when open; the end of the bridge having rollers to let it move more freely.

The roller bridge consists of a platform which is pushed forward, or withdrawn, by means of a pinion working in a rack on the under side of the platform, with friction rollers to render the work easier.

(For further particulars, see *Aide Mémoire to the Military Sciences*, from which the above has principally been taken.)

In civil engineering, draw-bridges are most frequently used upon canals, rivers, or in docks; and their construction is mainly regulated by the character of the navigation they are intended to accommodate, even to a greater extent than by that of the traffic over the bridge itself. The conditions which draw-bridges should fulfil are, in fact,—1, that they should be strong and steady; 2, that they should be rapidly and easily opened; and 3, that they should not interfere with the passage of the boats, or other craft, they are designed to pass. According, therefore, to the class of vessel so passing, the machinery by which the bridge is raised may be either above or below the floor-line; or the bridge may be either a *turning*, or a *bascule*, or a *rolling* bridge.

Upon canals, or rivers exclusively used for inland navigation by means of barges, there can be little reason for adopting anything but the old-fashioned Dutch lifting-bridge, in which the end of the lifting part of the floor is connected by means of chains to the extremity of a system of levers and counterpoises, and bearing at the opposite end to the bridge suspension-chains, a chain with handles, for the purpose of pulling down the counterpoise. This kind of lifting-bridge presents the advantages of being easily opened, and, from the fact of its machinery being raised above the floor-line, of requiring but slight elevation above the water-way, and thus dispensing with the necessity for long raised approaches. However, it is found to be objectionable in cases where masted craft pass, and even to entail some inconvenience in the navigation of rivers by steam-boats. Lifting-bridges are therefore exclusively reserved for canals, or for such rivers as those which traverse the towns of Holland and Belgium. From the fact of their requiring only light foundations, these bridges are peculiarly applicable in soft alluvial plains.

Turning-bridges are those most frequently used in docks, basins, or canals resorted to by masted vessels; because they fold back out of the way of the masts and yards, and also interfere in the least dangerous manner with the quay roads or walls. They are, however, very costly in themselves, and they require very expensive foundations. Upon some of the modern railways turning-bridges are introduced, by means of which two water passages are opened, the bridge itself turning upon a central pivot.

Bascule bridges were frequently used about the end of the last century for dock and river communications, as at Hull, Havre, &c.; but at the present day they are avoided, because it is found that the platform of the bridges stands in the way of the yards or the standing rigging of ships passing through the locks to which these bridges are attached. The same objection applies to the cost of the foundations and of the machinery of Bascule bridges as to those of the more commodious turning-bridges.

Rolling-bridges are used when it is not possible to construct above ground any machinery for lifting the platforms, and there are local difficulties in the way of executing the foundations of either of the other sort of draw-bridges. The manipulation of these rolling-bridges is, however, very complicated. A filling-in piece of the roadway, as wide as the opening it is desired to leave, is first rolled laterally, and then the bridge itself is rolled back into its place. The framing of the bridge is also costly; for during the time that the platform is being rolled back its end is without support, and it acts to cause deflection with a very long lever, thus entailing the necessity of a strong framing. Nevertheless, there are such manifest advantages in the introduction of rolling-bridges, when, if they were not employed, it would be necessary to resort to the use of the other descriptions of such structures as would require loftier approaches, that they are frequently used in railway, or even in dock works. The largest bridge of this description lately executed is the one erected to carry the railway over the Arun, near Arundel. The largest turning-bridge is the one carrying the railway over the Wornsum, in the county of Norfolk. It is to be observed, that railway engineers have, however, great objections to the use of draw-bridges of any kind, and that they are only resorted to in the last extremity.

DRAWER. [Bill of Exchange.]

DRAWING, in its strict meaning, is the art of representing objects on a flat surface by lines describing their forms and contours alone, independently of colour or even shadow. But shadow is closely allied with drawing, both in practice and in theory; because, notwithstanding that form may be clearly expressed by outline alone, shadow, while it gives surface and substance, is dependent upon form, and in many cases requires to be accurately defined according to the rules of perspective. More particularly is this the case when shadows are cast from any regularly-shaped body upon one or more planes; as, for instance, the shadow from a column upon a flight of steps, or that of a man upon the ground and a wall. It is true that, except in geometrical forms with sharp edges, very few such lines exist in nature, outline being no more than the boundary of surfaces as it exhibits itself to the eye. Thus, in the case of a globe or a cylinder, there are no lines whatever in the one, no edges down the latter; their outline being not on any part, but merely the termination of that portion of it which is visible. The same holds good with respect to the human form, and to that of animals, whose limbs have no determined edges, but consist of parts more or less curved, and even when nearly flat never stopping so as to form a specific line or positive edge. The outline of the superficies will consequently vary according to the direction in which the object itself is viewed.

Although drawing embraces all objects and their forms, in its more restricted technical sense it is generally understood to imply the drawing of the human figure, as that species of it which is the most scientific in itself and the most important in art. But correct drawing is none the less necessary for other objects which it is the province of the artist to represent. Landscape painting, it has sometimes been said, requires comparatively little skill in drawing and no great exactness of hand, since the forms it deals with, such as those of trees, mountains, rocks, &c., being altogether irregular, general fidelity as to form is sufficient; while fidelity of colouring and aerial perspective, and the effect of light, are the qualities most essential to it. But this fallacy, which has misled many young landscape students, must be discarded by him who wishes to paint landscape worthily. It is however true, that it requires greater expertness and decision to draw correctly even a statue than a tree or a mountain; the nicest observation of all the proportions, the most scrupulous attention to every lineament, to every minute detail, to every marking, every gradation of shadow, however slight, are here in fact indispensable. Yet in such case the draftsman has nothing more to do than patiently copy a perfectly immovable object. Far more arduous than such task is that of representing similar forms taken from the living subject. Here, unless he be also well disciplined and grounded in anatomical knowledge, the best models will avail him little save as studies of proportion, and of such positions and attitudes as, although they are intended to express motion, can yet be preserved for a considerable time. He may, indeed, thus perfect himself in that particular species of anatomical perspective which is termed foreshortening, and he may do much in the way of training both his hand and his eye, but for direct action and motion his model will serve only to inform him what muscles they are that are brought more forcibly into play, and other transitory phenomena which disappear almost as soon as they exhibit themselves. Indeed, some motions are so exceedingly rapid and fugitive that they cannot be drawn, and can hardly be studied from the life, but if attempted to be shown in painting must be represented according to theory based upon exact anatomical knowledge. Some attitudes and motions are either so exceedingly evanescent, as those of the figures hurled down in Rubens' picture of the Fallen Angels, or so purely imaginary, as when angels or winged genii are represented hovering in the air, that such theory alone will enable the artist to express them with any degree of apparent fidelity. The extremities—that is, hands and feet—are among the most difficult parts of the figure, and require great practice in drawing. Drapery, again, is, next to the figure itself, of the greatest importance, while it is less reducible to any positive rules for disposing it.

In order to attain to a complete mastery of the human figure, which after all is to be regarded only as the means to a higher aim, and the mechanical apparatus for effecting it, it is necessary to commence by studying what is tedious in itself, and seems almost foreign to the artist's purpose, namely, the internal configuration of the human frame. It is not enough to understand the proportions of the body and limbs, with the form and situation of the external muscles, but it is necessary that all the muscles, their purposes and functions, should be well understood. Nor must osteology, or the bones of the skeleton, be neglected. Indeed it is desirable that the artist should be able to draw the skeleton figure in any attitude, by which his figures will always be well put together. The drawings of Raffaelle and Michel Angelo show that those great masters, even when at the summit of their fame, used frequently to draw the skeleton of the more important figures of their compositions. By way of practice in this respect, it has been judiciously recommended that as soon as he is a perfect master of the skeleton, the student should proceed to draw antique statues in that state, afterwards clothing them with muscles, as in the marble or cast before him. But it is necessary to study muscular action with even more zeal and accuracy than the skeleton. Without scientific knowledge of muscular action, the painter will be able to give his figures only attitudes, and those not always correct, should he have occasion to represent such as from their nature do not admit of being copied from the life. Again, unless, besides possessing a complete knowledge of the human body and the action of the limbs and muscles, he is also able to express the emotions of the mind, and that not as they display themselves in the countenance alone, but in gesture, attitude, and the whole frame, he will at the best produce only clever academical figures, skilfully drawn, but devoid of soul and sentiment. He must therefore endeavour to make himself master of expression, in the most comprehensive meaning of that very arduous and complex study, which, be it observed, depends entirely upon drawing and truth of delineation. For this purpose such works may be recommended as Bell's 'Anatomy of Expression.'

Perspective, which is generally treated of separately, and is therefore ordinarily considered a distinct study, is nevertheless a most essential part of drawing,—in fact its very grammar, all objects being subject to its laws, although they may not admit of being delineated according to the processes employed for drawing buildings, furniture, and such things as consist of strict geometrical forms. Reserving the science itself for the article Perspective, we only advert to it here in order to press upon the student its essential and primary importance; and that, instead of being an extraneous accomplishment, it is inseparably connected with drawing; for perspective is based upon the laws of vision, and consists of practical rules deduced from those laws.

The student then would do well to exercise himself thoroughly in drawing before he proceeds to colour; and the longer he confines himself to outline, with no other degree of shadow than what is necessary to express the character, the substance, or texture, and the different prominences or depressions in the superficies of objects, the more likely will he be to attain precision and correctness, as there will be nothing to conceal vagueness and inaccuracy of form, but form will be exhibited undisguisedly either in its beauty or the reverse. One great step towards correctness is to understand perfectly beforehand the object to be represented, its character both general and specific; when this is the case, the hand, supposing it to be sufficiently well trained, readily obeys the eye and the mind. Constant observation, therefore, and as careful an examination of objects as if he were preparing to draw them, will greatly promote the student's advancement, and he will be really learning, when, because he is not actually at work with his pencil, he may seem to be doing nothing. And this applies equally to the student of scenery as of the figure. The more distinct and even scientific be his knowledge of nature and natural phenomena, the more truly and confidently will he be able to represent the appearances of nature; the wider his range of observation, the more likely will he be to avoid mannerism as well as to escape from signal mistakes.

We have spoken hitherto of the necessity of drawing accurately to the art-student, but drawing, as far as regards facility in delineating common forms and objects so as to enable a person to describe them promptly with the pencil, ought to be considered nearly as indispensable a part of education as writing itself. By this, such a degree of proficiency is meant as would enable a person either to express or explain his ideas upon paper, or to sketch from nature. Sketching, in the more popular meaning of the term, implies little more than the act of writing down in a kind of graphic shorthand the characteristic lineaments of a landscape or any individual object, an acquirement little more than mechanical, and which stands in about the same relationship to drawing, in its more elevated character, as an ordinary letter does to a finished literary composition. Like the sketcher, the draftsman only copies the objects before him, and those generally inanimate ones; but with this difference, that his drawings are expected to exhibit perfect fidelity, and admit of being worked up to a high degree of finish and beauty.

There are various manipulations or modes of drawing, distinguished according to the materials or implements made use of, such as chalk, black lead pencil, sepia, or other tinted drawings; which last-mentioned class are sometimes called washed drawings, in which some indication of colouring is occasionally introduced. But what is termed water-colour drawing, as now practised, is altogether a species of painting, although the process is totally different from that of oil colours, or even distemper. Pen and ink drawings in the style of etchings, either with or without the addition of wash of shadow, are capable of producing considerable effect. Still more effective are drawings either in black-lead pencil, chalk, or sepia, made on paper of a neutral tint, the bright lights being put on with white.

Painters' drawings or studies, such as those of the old masters, are highly valuable because they often exhibit their first conceptions in all their energy, and admit us to immediate intercourse, as it were, with their ideas as they arose in their minds. Collections of such drawings are found in most national and royal, and in many private, museums. The British Museum contains a very choice though not very extensive collection of drawings by the old masters. Perhaps the finest ever formed by a private individual was that of Sir Thomas Lawrence, P.R.A.; but it was dispersed after his death. The bulk of the Michel Angelo and Raffaelle drawings were purchased for Oxford University, and are kept in the University galleries. Of late, photography has been applied to the production of fac-similes of the drawings of painters, especially those of the old masters; and, the application ranks among the most interesting and valuable of that beautiful art. The art branch of the Department of Science and Art have therefore conferred a great boon on students of art by making photographic fac-similes of the exquisite drawings by Raffaelle in the British Museum, the Louvre, and especially the unrivalled collection belonging to the University of Oxford, and issuing them at almost nominal prices.

DREAMS may be best described, in a few words, as trains of ideas presenting themselves to the mind during sleep. The person to whose mind ideas present themselves in trains during sleep, is said *to dream*, and the word *dreaming* designates either the state of the mind in dreams, or else the susceptibility or potentiality of having dreams. We use the word in the former sense, when we speak of "the state of dreaming;" in the latter, when we say that "dreaming is a part of man's nature."

It is the principal design of this article to present the reader with the *psychological* theory of dreams: to explain, first, the psychological law by which dreams, as being trains of ideas, are regulated, and to exemplify the operation of this law; and, secondly, by means of this law and of certain psychological circumstances peculiar to the state of sleep, to explain the differences existing between dreams, as being trains of ideas which occur in the state of sleep, and trains of ideas as they generally occur in the waking state. When dreams, as psychological phenomena, shall have been thus explained (in the scholastic phrase) *per genus et differentiam*, the reader will be in possession of the whole psychological theory of dreams.

But dreams may give rise, as they frequently have given rise, to an inquiry other than the psychological inquiry which we have indicated, namely, one which in common speech is called a *physical*, but which would be better called, by coining a word analogous to psychological, *somatological* inquiry. Besides observing the mental phenomena of dreams, and referring these phenomena to a mental or (as we have before termed it) psychological law, together with certain psychological circumstances peculiar to the state of sleep, men may speculate on the manner in which the state of the body in sleep affects the mind—how the body when asleep is affected, and how again the body thus affected operates to the production of the phenomena of dreams. Of this physical or somatological inquiry, the greater and more important part, that which relates to the state of the body, belongs properly to the subject of sleep; while, as regards the manner in which the state of the body operates to the production of the phenomena of dreams, to determine which observation gives very small assistance, we shall state, in a second division of this article, the little that can be relied on.

In the third part of the article we shall give a few well-attested instances of dreams, accompanied by circumstances which, as they are related, do not seem to admit of explanation. And this will lead us naturally to say a few words concerning the supernatural character which, at different times and in different countries, has been attributed to dreams.

I. We have said that dreams are trains of ideas presenting themselves to the mind during sleep. Occasionally, and under peculiar and definable circumstances, *sensations* are felt during sleep; some of which commonly do not awake the dreamer, while others, which awake him, are yet shown to have been felt during sleep by the circumstance that a train of ideas called up by them passes before the mind, invested with the attributes of dreams, in an interval between the sensation and the waking. These sensations, however, are, from the nature of the case, comparatively so few, and, even when they are felt, so unimportant in comparison with the ideas which they call up, that they may very well be excluded from notice in a general description of dreams.

Bearing in mind then the existence of these few and unimportant exceptions, we shall henceforward speak of dreams as consisting only of ideas. And that the feelings composing dreams, which are at the time believed to be sensations, are not sensations, but only ideas,—that we do not see, hear, smell, taste, and touch what we believe at the time that we respectively see, hear, smell, taste, and touch, but that we only have the ideas of these respective sensations, cannot need proof. At any rate, the only proof which the nature of the case admits is one to be furnished by each individual for himself. Knowing the circumstances which, when he is awake, are concomitant with the having the feelings called *sensations*, and the circumstances which are concomitant with the state of sleep and of dreaming,—knowing further that these two sets of circumstances are incompatible with one another; while, on the other hand, the circumstances concomitant, when he is awake, with the having the feelings called *ideas*, are such that he may very well have them likewise when he is asleep; he cannot but conclude for himself (and if he do not, other means of proving it to him there are none) that the feelings of which he is conscious during sleep are not, as at the time he believes them to be, sensations, but ideas. He knows that when he is asleep and dreams, he is so situated that he cannot have the sensations which at the time he believes that he has. He knows that he *may*, in his then situation, have ideas; and, if he has any feelings at all, *must* have ideas. He must conclude then that what at the time he believes to be sensations are in reality only ideas, and must consider the appearance of these ideas as sensations, as a matter to be explained by means of psychological circumstances peculiar to the state of sleep.

Dreams, then, being thus assumed to be trains of ideas, we proceed to investigate the law by which they are regulated, and to exemplify the operation of the law.

On observing, or (to use the phrase which, when mental phenomena are spoken of, is more common) reflecting upon, our waking train of ideas, we find that when two sensations, or two ideas, or a sensation and an idea have occurred in proximate succession, the sensation that occurred first, or its idea, or the idea that occurred first, is afterwards followed by the idea of the sensation that occurred second, or (as the case may be) by the idea that occurred second, and that this happens the more surely in proportion as such proximate succession of the two sensations, or two ideas, or sensation and idea, has been more recent, and in proportion as it has been more frequent. Such is a brief statement of what is called the law of association, and of its laws. [ASSOCIATION.]

"When a man thinketh on any thing whatsoever," says Hobbes, "his next thought after is not altogether so casual as it seems to be. Not every thought to every thought succeeds indifferently. But as we have no imagination (idea), whereof we have not formerly had sense in whole or in parts; so we have no transition from one imagination to another, whereof we never had the like before in our senses." ('Leviathan,' i. 3.) Hobbes has here enunciated the principle of previous proximate succession, or contiguity (whatever it may be called), and has spoken of it as the sole primary principle of association; the only defect in the manner in which he has enunciated it being the omission of the instances of two ideas, and of a sensation and idea occurring in proximate succession. Most subsequent writers on the subject have added other primary principles, more or less, to this one enunciated by Hobbes; and in so doing are, we think, chargeable with an imperfect analysis. Mr. Hume enumerated three principles, contiguity in time and place, causation, and resemblance; a fourth, contrast, which he named, he looked upon as a secondary principle resolvable into causation and resemblance. ('Essays,' vol. ii., p. 21.) Dr. Brown, finding great fault with Mr. Hume's enumeration, and observing that all suggestion (the phrase employed by him in the place of association) depends on prior co-existence (by which he means the same as we by proximate succession), nevertheless does not seem to have perceived the processes by which resemblance and contrast may be resolved into this principle, and furthermore treats the topic under the threefold division of resemblance, contrast, and contiguity in place or time, all which he inconsistently calls primary principles. ('Lect,' 34 foll.) Mr. Mill has two principles, subdivisions (and perhaps unnecessary subdivisions) of the one principle, as it is represented by Hume and Brown, contiguity; he calls them the "synchronous order," which, he says, answers to contiguity in place, and the "successive order," which, he says, answers to contiguity in time. ('Analysis of the Human Mind,' vol. i. p. 53.) He observes rightly, that the principles of causation, resemblance, and contrast, may be resolved into previous proximate succession; though he does not go through the analyses, and indeed the few hints which he gives of what he deems the necessary processes seem to show that he did not understand them.

The mode of resolving causation is obvious; causation indeed is but a name for previous proximate succession, under particular circumstances. Let us briefly explain (Mr. Mill not having done it) the modes of resolving resemblance and contrast into the same principle; taking, which is the most convenient method in such cases, a particular instance of each.

The sight of a man, A, calls up the idea of another man, B, who resembles him. Some of the sensations and ideas which are elements of the complex feeling called *the sight of A*, have been before present to the mind as elements of the complex feeling called *the sight of B;* and these sensations and ideas call up the ideas of the other sensations and the other ideas which go to make up the complex feeling called *the sight of B*, and which are not elements of the complex feeling called *the sight of A;* for with these other sensations and other ideas they have before existed in proximate succession, or (as we may say for shortness) have co-existed. These ideas, thus called up, co-exist (as we may again say for shortness) with the ideas of the sensations, and with the ideas, which, belonging both to the sight of A and the sight of B, called them up; and thus the idea of the sight of B, or the idea of B, is present to the mind.

Again, as regards contrast, the idea of a giant calls up the idea of a dwarf. One idea that is an element of the complex feeling called *the idea of a giant* is the idea of tallness, which idea is made up of the idea of height and that of greatness. The idea of tallness, and therefore that of height, is a vivid idea, or (changing the phrase) it is an idea on which the mind dwells, or which very frequently presents itself to the mind when a giant is being thought of; and so when a dwarf is being thought of, is the idea of shortness, which again includes the idea of height, a vivid idea. Now the idea of height being a vivid idea, or one which very frequently presents itself to the mind when a dwarf is thought of, is strongly (and strongly by reason of the frequent proximate succession of the two ideas) associated with the idea of a dwarf, as it is, for the same reason, strongly associated with the idea of a giant. The idea of the giant then calls up the idea of height, which has frequently before (as we may say for shortness) co-existed with the idea of the giant; and the idea of height thus called up, calls up, for the same reason, the idea of the dwarf.

We have dwelt thus at length on the psychological law of association, and its primary principle of previous proximate succession, because it may be said to be the key to the whole psychological theory of dreams. This law being fully comprehended at the outset, so much of the remainder of our task as consists in the exemplification of its mode of operation is made straightforward and easy.

We arrive at the law of association, as determining waking trains of ideas, by the processes of observation and of induction. We may either extend the law, thus arrived at in the case of waking trains of ideas, to the case of dreams, knowing independently that these are made up of ideas and are therefore not different in kind from waking trains; or again we may arrive at the law, in the case of dreams separately, by the same processes of observation and induction. The former mode is as satisfactory as the latter; and in the way of this latter there are many difficulties, arising out of the nature of the case, which do not exist as regards the former. By the former mode, therefore, which is the easier, and which is at the same time logically correct, we come to the conclusion that, in dreams, one idea is followed by another idea, when either the sensation of which the first is the copy has, at a previous time or times, been followed by the sensation of which the second is the copy, or when one of the ideas has followed or been followed by (as the case may be) the sensation of which the other is the copy, or again when the ideas themselves have been, at a previous time or times, present to the mind in proximate succession; and that this happens the more surely, or (changing the phrase) the association between the two ideas is the more strong, in proportion as the previous proximate succession has been more recent, and in proportion as it has been more frequent. Of the law thus modified by the circumstances of recency and frequency, *causation*, *resemblance*, and *contrast*, are names for classes of instances; and in dreams, as in waking trains, the idea of what is called a cause is generally followed by the idea of what is called its effect; the idea of an object which resembles another object is generally followed by the idea of the object which it resembles; and the idea of an object which is said to be contrasted with another object is sometimes followed by the object with which it is said to be contrasted. We will now exemplify, with somewhat more particularity, the operation of this law of association in dreams.

1. The classes of associations which make up the greater part of our mental history when we are awake, those concerned in naming, in classification and abstraction, in memory, in belief, in reasoning (whether to ourselves or by word of mouth, or in writing), in imagination, in desires and aversions, in affections, occur likewise during sleep, and make up a considerable part of our mental history in sleep, that is, of our dreams. It will not be necessary to give instances of the occurrence of each of these classes of associations, as every one who is conscious of having dreamed must be conscious of having had these several states of mind during his dreams. And further, the giving of the instances would be of little use, unless the instances given of the several states of mind were analysed, and the associations forming these several states of mind set forth in the particular instances given; but this, even were it relevant to our present purpose, would carry us to an unreasonable length. Referring the reader then to Mr. Mill's masterly work, entitled the 'Analysis of the Human Mind,' in which the working of the law of association is thoroughly developed, we shall content ourselves with a couple of instances of reasoning and imagination, and with an exemplification of belief, of that kind which is most important for the full comprehension of dreams.

We not only converse, in dreams, with the persons whom we believe to be present, speaking to them, and again attributing to them connected words which we believe that they speak to us, but we frequently go so far as to make a speech or written dissertation, which, as remembered when we have awoke, is not only coherent, but often (owing to psychological circumstances peculiar to the state of sleep) more clearly and forcibly arranged than it would have been had we been awake, and had we actually spoken the speech or written the dissertation. Condillac is said to have often brought to a conclusion in his dreams reasonings on which he had been employed during the day, and which he had not completely worked out when he retired to bed. (Cabanis, 'Rapports du Physique et du Moral de l'Homme,' ii. p. 395.) Cabanis says, in the same place, of Franklin:—"I knew a very wise and enlightened man who believed he had often been instructed in his dreams concerning the issue of events which at the time occupied his mind. His strong head, and his freedom, in every other respect, from prejudice, had not been able to guard him against a superstition in respect of these inward warnings. He observed not that his profound skill and rare sagacity continued to direct the action of his brain during sleep." The circumstances under which Mr. Coleridge composed the fragment called 'Kubla Khan,' have been described by himself as the following, and we see no reason to discredit his statement. He had taken an anodyne which had been prescribed to him in consequence of a slight indisposition, and fell asleep in his chair while he was reading in 'Purchas's Pilgrimage,' of a palace built by Khan Kubla; he remained asleep for about three hours, during which, as he himself tells us, "he could not have composed less than from two to three hundred lines; if that indeed can be called composition in which all the images rose up before him as things, with a parallel production of the correspondent expressions, without any sensation or consciousness of effort." On awaking he instantly sat down to commit his poem to paper. After having written so many lines as were afterwards published, he was interrupted by a person on business; and when he returned to the task the poem had vanished from his memory.

Our belief in the presence of external objects not present is one of the most curious and, from the frequency of its occurrence, together with its curiousness, one of the most important of the phenomena of dreams. This belief is a complicated case of association. When we are awake, and, having sensations of sight from a present object, believe that the object is present, we have, first, the sensations of sight which the object excites, then the ideas of distance and extension and figure, which are closely associated with these sensations: again, the ideas of all the other sensations which the object has at other times and in other circumstances excited (those of resistance, smell, sound, &c.), and of ourselves as having these sensations: and, lastly, the idea of a cause of all those sensations, whether present or past, whether those which are themselves, or those of which only the ideas or copies are present to the mind. All those ideas, inseparably associated with the sensations of sight of which we are conscious, make up the complex state of mind called *belief in the presence of external objects*, or *belief in the existence of external objects present*. The same ideas, inseparably associated with the ideas of the sensations of sight which were themselves present in the former case, constitute another complex state, which is also a state of belief in the existence of the external objects, but which, having ideas of the sensations of sight instead of the sensations themselves, is thus distinguished from the former state, and which may be called *belief in the existence of external objects not present*. This last state of mind is the one which occurs during sleep, appearing to be the former one. Why it so appears we shall explain presently. At present we have had to do only with what it actually is, and with the associations which it comprehends.

2. It is said that a man's character and pursuits influence his dreams. Now we mean by the phrase "a man's character," nothing more than certain classes of association which occur to him most frequently; and his "pursuits" again, viewed subjectively or in respect of himself pursuing, may be paraphrased in the same way. When we say then that a man's character and pursuits influence his dreams, it is only a way of saying that those associations which most frequently occur when he is awake will also occur most frequently, *cæteris paribus*, when he is asleep. This circumstance, therefore, observed in dreams, exemplifies the manner in which frequency strengthens association. It would be but a waste of words to bring particular instances in support of the general remark; and indeed it will be incidentally exemplified in some of the illustrations which we shall presently adduce of the influence of sensations on dreams.

3. Dreams turn upon subjects which have been present to the mind recently, rather than those which have been present to it at a greater distance of time. In other words the most recent associations will recur, *cæteris paribus*, the most frequently in our dreams. As under the last head, therefore, was exemplified the influence of frequency on association, so under the present is that of recency exemplified; and it will not be necessary to dwell any longer upon this than upon the last topic.

4. We shall enter at rather greater length into the manner in which the sensations occasionally felt in sleep modify dreams through association. We have already alluded to the occasional occurrence of these sensations. They are themselves very unimportant parts of dreams, even when they occur; but they call up vivid and interesting trains of ideas, the

connection between which and the sensations it is amusing to trace. We shall take the different kinds of sensations separately.

a. Of the five external senses, sight is the least excitable during sleep. But a strong light brought before the eyes of a person sleeping generally affects the nerves concerned in the sensation of sight; a sensation of a light is generally felt; and whilst its ultimate effect is almost always to awaken the sleeper, a train of ideas associated with the sensation of a light is first called up, and passes before the mind in the interval between the sensation and waking. The sleeper probably awakes from a dream of some conflagration, whether one which has actually taken place (for instance, the conflagration of Moscow, or any other which may have been impressed on his mind), or else a conflagration of some house well known to him, perhaps even his own.

b. The least excitable of the senses, after sight, is taste. And even so far as it is excitable, the circumstances under which we sleep are such as to preclude almost entirely the possibility of its being brought into action. When, however, from ill-health, or in consequence of something which we have eaten shortly before going to bed, there is (in the vulgar phrase) a bad taste in the mouth, this may have its effect on dreams.

c. Smell comes next of the senses, in respect of defect of excitability during sleep. The circumstances under which we sleep are again such as to preclude almost entirely the action of this sense; and it is difficult, while it is by no means important, to select an apposite instance of its operation in modifying dreams.

d. We come next to the sense of hearing. "The sound of a flute in the neighbourhood," says Mr. Macnish, "may invoke a thousand beautiful and delightful associations. The air is perhaps filled with the tones of harps, and all other varieties of music; nay the performers themselves are visible; and while the cause of this strange scene is one trivial instrument, he may be regaled with a rich and melodious concert" (p. 61). A loud noise taking place near the sleeper, heard by him, and eventually awaking him, calls up ideas of various loud noises, and these again various other ideas associated with them. A curious instance, which exemplifies the tendency of ideas that have been most frequently and most recently present to the mind to recur in dreams, will be found in Dr. Abercrombie's work on the Intellectual Powers, p. 277. Again, whispering in a person's ear when he is asleep is found sometimes to modify his dreams very considerably. Some persons, it is true, are instantly awaked thereby; others, who sleep on, are not conscious when they awake of having had dreams akin to the subjects on which the whisperer has discoursed; while others again may have their dreams modified at one time by the whispering, and not at another, according as the sleep is more or less deep. But instances are recorded of persons susceptible always, and, to a peculiar degree, of the influence of this whispering in the ear on their dreams; an amusing instance of which is also given by Dr. Abercrombie.

e. Of the five external senses, touch is the most excitable during sleep. In continually changing, as we do, our position during sleep, we are influenced by tactile sensations of which the bed and the bedclothes are the causes. We are most easily awaked by being touched, the slightest tickling in the nose or the sole of the foot being sufficient for the purpose. And as regards the operation of sensations of touch in modifying dreams, let it suffice to observe generally, that those by which we are awaked may call up, in the interval between the touch and the waking, ideas of various causes of touch which will be pleasurable or painful ideas according to other circumstances.

f. Sensations of bodily pain, or of disorganisation (as they have been named by Mr. Mill, who has been the first to treat of them under a separate head), including the sensations of heat and cold, frequently occur to modify dreams. Hobbes has enunciated this modifying circumstance with distinctness, interweaving however a somatological hypothesis for its explanation which is neither necessary nor correct; but this hypothesis may be kept apart from the enunciation of the fact. "And seeing dreams are caused by the distemper of some of the inward parts of the body, divers distempers must needs cause different dreams; and hence it is that lying cold breedeth dreams of fear, and raiseth the thought and image of some fearful object (*the motion from the brain to the inner parts, and from the inner parts to the brain being reciprocal*); and that as anger causeth heat in some parts of the body when we are awake; so when we sleep, the over-heating of the same parts causeth anger, and raiseth up in the brain the imagination of an enemy." ('Leviathan,' i, 2.) Several instances have been related of this by Dr. Abercrombie, Dr. Gregory, and others.

g. Sensations in the alimentary canal, sometimes pleasurable and sometimes painful, have a very important influence on dreams. These sensations indeed influence very considerably our waking trains of ideas; and much more, inasmuch as in sleep there are no external objects to call us away from the ideas which these sensations call up, do they influence our sleeping trains. When the digestion is good, and we have eaten nothing which weighs upon or disagrees with the stomach, our dreams are, generally speaking, pleasurable. When, on the other hand, we suffer from indigestion, which, in respect of the effect, is but a name for an aggregate of painful sensations in the alimentary canal, we are afflicted with dreams of the most painful character. The exhilarating effects of opium and of intoxicating draughts, which effects are neither more nor less than sensations in the alimentary canal, are also discernible in dreams. And in connection with this topic, we may allude to the dreams caused by the uneasy sensations attendant on obstructed respiration, which, sometimes caused by and sometimes combined with indigestion, constitute the most dreadful evils to which in sleep we are subject, and which are known to all under the name of nightmare.

We have thus explained the law of association which determines the formation of dreams, and have exemplified its operation. Thus far, it will be observed, we have spoken of dreams only in their generic character of trains of ideas; or at least, any reference which we have made to the specific circumstances which distinguish them from trains of ideas in the waking state has been incidental. It remains, in order to complete the psychological theory of dreams, to state and explain the circumstances distinguishing dreams, as trains of ideas during sleep, from trains of ideas as they generally occur in the waking state. We say as they generally occur, because in the waking state there are trains of ideas, which occur under peculiar circumstances, resembling dreams, and differing from the generality of trains of ideas in the waking state in those very points by means of which dreams, and the generality of waking trains, are to be distinguished from one another. The trains of ideas which in the waking state occur thus under peculiar circumstances are those called *reveries*, or, more expressively, *waking dreams*; and again, those which present themselves to the mind during delirium.

1. Ideas which occur in dreams are believed to be sensations; scenes fashioned by the fancy are believed to be real. What has been already said, when we were resolving this belief in the presence of external objects not present into its component elements, in order to exemplify the operation of the law of association in dreams, has expedited the explanation of this phenomenon. When we are awake we are conscious continually of two different states of mind, belief in the existence of external objects present, and belief in the existence of external objects not present. These two states of mind differ only in this point, that the former comprehends certain sensations of sight, while the latter, in the place of the sensations themselves, has but the ideas of the sensations. Now, when we are awake, ideas are compared with sensations, the belief in the existence of external objects not present with the belief in the existence of external objects present; and ideas are seen to be less vivid than sensations, the former belief than the latter belief. Thus, and thus alone, are these states of mind respectively distinguished from each other when we are awake; but when we are asleep we have no sensations with which to compare our ideas, and no external objects present, with the belief in whose presence we can compare the belief in their existence when they are not present. Ideas therefore, no longer viewed relatively, take the place of sensations; they are the most vivid representations which present themselves to the mind of the qualities of external objects; and being the most vivid, are believed to be sensations. Whence it follows, that the belief in the existence of external objects not present takes the place also of the belief in the existence of external objects present, or (changing the phrase) the belief in the presence of external objects. It may also be, that ideas when we are asleep are, from bodily causes which we cannot trace, actually more vivid than are the same ideas when we are awake: if this be so, which we cannot positively say, but which is probable, it will combine with the previous consideration to explain the above-mentioned phenomenon.

Dr. Hartley wrote upon this point with great sagacity; and the only fault in the following extract is the intrusion of a material hypothesis at the end of it. "The scenes which present themselves are taken to be real. Now this happens, first, because we have no other reality to oppose to the ideas which offer themselves, whereas in the common fictions of the fancy, while we are awake, there is always a set of real external objects striking some of our senses, and precluding a like mistake there, or if we become quite inattentive to external objects, the reverie does so far put on the nature of a dream as to appear a reality; secondly, the trains of visible ideas which occur in dreams are far more vivid than common visible ideas, and therefore may the more easily be taken for actual impressions. For what reasons these ideas should be so much more vivid, I cannot presume to say. I guess that the exclusion of real impressions has some share, and *the increased heat of the brain may have some likewise*. The fact is most observable in the first approaches of sleep, all the visible ideas beginning then to be more than usually glaring." ('Observations on Man,' vol. i. p. 398, ed. 1810.

Thus it is that we never dream of a past event as a past event. Any historical event of which we dream is believed to be taking place before our eyes, and any historical individual to be our companion. Another singular consequence is observable in the case of dreams produced by sensations of bodily pain. The sensation of the pain may call up, as well as kindred ideas of pain and its causes, an idea of that which will remove the pain, which, when we are awake, must often follow the sensation of pain; and this idea will be taken for the actual presence of that which is fitted to relieve us. When, for instance, we hunger or thirst in sleep, these uneasy sensations call up respectively the ideas of food or drink; we believe that we have food or drink in our possession, but (the hunger or thirst of course continuing) we go on to dream of some occurrence which prevents the satisfaction of our appetites; or perhaps we have the idea of the taste of the food or drink, and believe that we have the sensation of tasting, but yet the hunger or thirst is not allayed. Immediately some other viand or beverage presents itself to us; again are we debarred from the enjoyment, or again do we taste and profit not; and thus does the dream proceed until we awake.

The incongruity of dreams, or (in other words) the grouping of objects in our dreams which could not exist together in reality, results immediately from this mistaking of ideas for sensations. There is no more incongruity in the collocation of our ideas themselves during sleep than in that of our ideas in the waking state. In both states they follow one another according to the same law. But when we have ideas of objects during sleep, we believe that the objects are themselves present; and though the collocation of the ideas is natural, and such as would excite no surprise in the waking state, the collocation of the objects is strange, and would then also excite surprise. Dreams, though only trains of ideas, are believed at the time (as has been explained) to be successions of objects, and when afterwards remembered as such, they seem strange and incongruous. Dryden's poetical description and instance may here relieve the weariness of our own prose:—

> "Dreams are the interludes which fancy makes:
> When monarch reason sleeps, this mimic wakes,
> Compounds a medley of disjointed things,
> A court of cobblers or a mob of kings."

2. There being no sensations in sleep, as in the waking state, to break off the trains of our ideas, the associations which have been at any previous time or times formed between these ideas have more uninterrupted play when we are asleep than when we are awake. When we are awake, one idea calls up another, this perhaps a third, and thus a train of ideas is commenced, when of a sudden we see some object; the sensation then takes possession of the mind, and (in the common phrase) the attention is withdrawn from the train of ideas. When we are asleep this cannot happen; and an association between any two ideas has to give way only to a stronger association between one of them and a third.

The greater coherency, than if they were made by us when awake, of speeches or essays which we believe in our dreams that we speak or write, has been already noticed.

Thus it is that we often go through a repetition in our dreams with considerably greater ease than we can do it when awake. For the same reason, again, ideas occur to us in our dreams of which we have not for a very long time been conscious when awake, and which we have been perhaps unable, when anxious to do so, to call up; and trains of ideas are gone through, which we have, perhaps, wished to complete when awake, but to no purpose, inasmuch as the associations between the several pairs of ideas in the trains are too faint to bear up against the continual interruptions of sensations. These ideas and trains of ideas occurring in dreams, which we are unable to call up when we are awake, are said to have been forgotten.

We may observe, that the same revival of long-forgotten ideas and trains of ideas takes place often during delirium, the similarity between our trains in which state and our dreams we have already alluded to. A very singular instance of such revival during delirium is related by Mr. Coleridge, in his 'Biographia Literaria' (vol. i. chap. vi.).

To this head is to be referred a remark generally made concerning dreams, that the mind exercises no control over the ideas which compose them, or (as it is otherwise expressed) that the mind does not exert its will upon them, as it does upon ideas composing trains in the waking state. The mind is not diverted from the trains of ideas which pass before it by the occurrence of sensations; thus it need not desire, as it continually does in the waking state, to have the ideas composing the trains rather than the sensations; and thus the ideas are not presented to it, as they continually are in the waking state, in that particular combination which is called *desire of the ideas*, or *willing of the ideas.* This, we believe, is the full extent to which the remark concerning the absence of will (as it is called) over ideas in dreams is true; though, from the manner in which it is expressed, it seems, and indeed it is generally intended, to imply much more.

When we are awake, we are said to will bodily actions, and to will mental actions or ideas. Now, when we are asleep, we will bodily actions likewise; but from the manner in which the body is affected during sleep, the actions do not follow the state of mind called *will*, as they do when we are awake. We will to run from an enemy who, we believe, is pursuing us, but we cannot run; the muscles are so affected in sleep that their action does not follow the state of mind called *will*, as it does when we are awake. Every one who has dreamed must have experienced such a dream as this, and must remember the fear which follows it. But the circumstance that the action does not follow by no means affects the existence of the state of mind called *will* during dreams; and in sleep therefore, as in the waking state, we will bodily actions. Again, as regards mental actions or ideas, we exert our will over these, in the waking state, either by attending to them, or by endeavouring to recollect them, and in no other way; and every one who has dreamed must be conscious of attention to trains of ideas during his dreams, and of endeavours to recollect ideas. Thus neither as regards mental actions is there any absence during dreams of the state of mind called will.

The only difference in respect of this state of mind between dreams and waking trains is, as we have said, that in the former there is not so much need of attention to the ideas as in the latter; inasmuch as dreams are not interrupted by sensations, as are trains of ideas in the waking state.

3. Our measure of time during dreams appears not to coincide with that in the waking state. Having fallen asleep for a few moments, we believe that we go through, before we awake, a series of events which would occupy, did they really happen, days or months, or even years. And the same takes place often, when a sensation occurs to awake us, in the brief interval between the having of the sensation and the waking. Instances are not unfrequent of such dreams.

This discrepancy between our notions of time when we are asleep and when we are awake may be very easily explained. The idea of time is only an idea of so many successions of events, or of ideas, whether called up by these events or otherwise. On looking back through any period of our mental history, if we remember many feelings that have succeeded the one to the other, we have the idea of a long time; if few, of a short one. Now ideas are remembered in proportion as they are interesting or vivid. In the waking state and in sleep the same ideas would pass before the mind during the same time; but in the waking state they would be viewed as ideas only, and the greater number would not be remembered. But in sleep they are believed to be sensations, the events thought of are believed actually to take place, and the ideas thus become interesting to such a degree that they cannot be forgotten. Looking back through these ideas, and remembering every one of them, we judge the time during which they have passed before the mind to have been a long time.

4. It remains to speak of the absence of surprise in dreams. It is not indeed true that the feeling of surprise is altogether absent from dreams, as is generally asserted; while in those cases in which it is absent, and in which its absence is thought worthy of remark, the explanation is simple. In our dreams we believe that we see persons who are either dead or in a distant country, and we are not surprised; we believe that we witness events which happened a very long time ago, and we are not surprised. Now we have the ideas of the persons and events, and we have not at the same time the ideas of the death or the distant country or the distant time at which the event took place; having the ideas of the persons and events, we believe these ideas, as has been already explained, to be sensations; and as we have not, together with the apparent sensations, the ideas of the death, distant country, &c., we have no ideas with which the apparent sensations are incongruous; and there being no incongruity, there is nothing to surprise us. We think of the persons or events, as we might think of them when awake, without certain additional ideas; and not having these additional ideas, we are not surprised at seeing, or believing that we see, the persons or events, any more than we should be surprised at seeing (could we by possibility do so) the same persons or events when we were awake, if we knew not that the person had died or was in another country, or that the event was one of history.

This explanation is confirmed by those instances in which we do feel surprise. The idea of a person or event believed to be seen may call up any of the additional ideas that have before been absent. We believe that we see a person, and we then think of his death; we are immediately surprised; and we dream that we are dreaming. Every one who has dreamed must have experienced such a dream as this.

II. This second part of the article was to contain so much of the little that is known concerning the state of the body in sleep as is relevant to the subject of dreams.

The organs of the five external senses are so affected by sleep, that the sensations which respectively pertain to them are either not felt at all, or are felt very much less often, and very much less, than when we are awake, and even when they are felt they generally awake us. But of this we have already spoken.

We have also spoken of the effects of sensations of bodily pain and of internal sensations on dreams. The manner in which sickness, through the medium of internal sensations, intensifies dreams, is familiar to every one.

It is a question whether sleep operates on the mind as well as on the body; whether, while it suspends the action of the body, it also, either through the body or otherwise, suspends the action of the mind. This is a question on which we cannot speak positively, and on which our opinion can be determined only by the greater *probability* of th one side or of the other

Some writers assert that we do not always dream when we are asleep. They say that the proper effect of sleep is to suspend the action of the mind as well as of the body, and that, to the extent to which we dream, sleep is impaired. They speak of two kinds of sleep, the one in which we do not dream, and which they call *perfect* sleep; the other, in which we dream, and which they call *imperfect.* One of these writers is Mr. Locke, who has expressed a very decided opinion that during sleep we do not always think; his arguments in favour of the opinion being, that all of us are conscious of having no dreams during a considerable portion of the time that we sleep, that some persons even do not dream at all, and that a supposition that the dreams are forgotten almost the very moment after they have taken place is absurd.

('Essay on the Human Understanding,' 2, i. sec. ii.) If, however, we do not dream always, how is the beginning of our dreams accounted for? The mind is, on this supposition, at a particular period of sleep, void of ideas; an idea suddenly enters it, and dreaming begins. Now the idea was not called up by an idea antecedent to it, for antecedently there was no idea in the mind. How then did it come to enter the mind? This consideration appears to us adequate to set the question at rest as to whether we dream always or not.

Dreaming always, we may remember or forget our dreams according to whether our sleep is deep or slight, and remember them in proportion as it is not deep. One part of the same fit of sleep is more intense than another; the dreamer remembers the dreams of this last part, but forgets those of the first, as regards which it is the same as if he had not dreamt at all. In one state of health the same person has a greater amount of deep sleep than in another; he in consequence remembers his dreams better, or (as he would most probably express it) he dreams more in the second state of health than in the first. Again, one person's bodily constitution is such as to make his sleep generally more intense than that of another person, and in consequence he is less of a dreamer. There have been instances of persons who do not remember ever to have dreamed, and of others who have not remembered any dreams until at a very advanced period of life.

III. As regards the instances recorded of extraordinary dreams, they are either untrue, or true and explainable by ordinary or natural means, or else true and not so explainable, and therefore (in the common phrase) supernatural. Now many of these instances are so far authenticated, that we are not authorised altogether to discredit them. Not discrediting them, we are yet unable to explain them by the ordinary means; though it is possible, certainly, that as the dreams and their attendant circumstances come to us, there may be both some exaggeration in the dreams themselves, and some omission of incidents previous to the occurrence of the dreams which might help to explain the attendant circumstances. Again, there is another set of incidents, also well authenticated, which, like these instances of dreams, are, if we believe them as they are related, unsusceptible of explanation by ordinary or natural means. We refer to the many stories told of the appearance of persons at the moment of death, to friends or relations at a distance from the spot where the death takes place. Now these incidents pave the way to some extent for a belief in the supernatural character of some remarkable dreams. If these incidents are believed to be supernatural, there is no reason why there should not also be supernatural dreams. We must observe, however, that in calling either the incidents to which we have referred or the dreams supernatural, we mean no more than that they cannot be explained by natural means. We cannot say how they were brought about; neither can we say, looking at the particular circumstances under which they happened and the particular persons to whom they happened, why they were brought about.

The supernatural interpositions to which, in our difficulty, we resort for aid, must, if they exist, be determined by general laws, which in the course of time it either may or may not be given to men to know. At present we see only the particular interpositions, particular events belonging to another system, which we call supernatural, which is governed, however, doubtless, like our own or the natural system, by general laws, and which moves perhaps co-ordinately with this to a common end, although we know not the laws of that system, nor the connexion between it and our own. It is certainly not philosophical to refer each particular interposition to a particular providence, as is done by Bishop Bull in his sermon concerning the 'Holy Office of Angels;' but in an admission of our own ignorance, combined with an opinion that the interpositions (as they are called) are regulated by general laws, there seems to be nothing to be objected to.

Many dreams which have in former times been accounted supernatural, as revealing facts and truths of science, may doubtless be explained by means within our own knowledge. Reference has been made to Franklin's belief in revelations made to him during dreams concerning political events, but those revelations admit of a natural explanation.

There are several instances of dreams, similar to these related of himself by Franklin, given by Henry More in his 'Immortality of the Soul' (ii. 16), all of which may be explained similarly; as, for instance, the dream of Avenzoar Albumaron, an Arabian physician, to whom his lately deceased friend suggested in his sleep "a very soverain medicine for his sore eyes." Indeed all dreams of the appearance of ghosts, where they are believed to relate what may have been before known to the dreamer, may be explained by the two circumstances, that ideas in dreams are taken for sensations, and that trains of ideas associated together are not liable to be interrupted by sensations, as they are in sleep. Mr. Coleridge has very happily observed that, in the cases where ghosts are believed to appear in dreams, we have the idea of the person to whom the ghost belongs as being in the room in which we ourselves are sleeping; and further, that such ghosts always appear in a half waking state, when "the impressions of the bed, curtains, room, &c., received by the eyes in the half moments of their opening, blend with, and give vividness and appropriate distance to, the dream image, which returns when they close again." ('Literary Remains,' vol. i., p. 202.)

There is a long 'Essay on the Phenomenon of Dreaming,' in Baxter's 'Inquiry into the Nature of the Human Soul;' the object of which is to prove that dreams are brought about by the agency of spirits. However fanciful is this object, the essay is valuable, as containing many facts and displaying much ingenuity.

The theory of dreams is treated briefly in Dr. Hartley's work, in Mr. Stewart's 'Philosophy of the Human Mind' (vol. i., chap. 8), in which, however, but little is done towards the elucidation of the subject; and in Dr. Beattie's 'Dissertations.' (Lond. 1783, 4to.) Dr. Abercrombie's and Mr. Macnish's works are valuable for nothing else than the instances which they furnish. There is an article, occasioned by Mr. Macnish's book, and written by Sir William Molesworth, in the first volume of the 'London Review,' which shows great metaphysical acumen, and from which the reader will derive much instruction. A work by Dr. Brierre de Boismont, well translated and somewhat condensed by Mr. R. T. Hulme, 'On Hallucinations; a History and Explanation of Apparitions, Visions, Dreams, Ecstacy, Magnetism, and Somnambulism,' London, 1859, may also be consulted with advantage.

The works of Aristotle contain a short treatise on dreams (περὶ Ἐνυπνίων); and many valuable observations, as well as fancies, are scattered through the poem of Lucretius. There is also extant, in Greek, a work on dreams by Artemidorus, besides the 'Oneirocritikon' of Astrampsychus, and that attributed to Nicephorus, a patriarch of Constantinople.

DREDGING-MACHINES are machines employed for deepening and clearing away deposited matter from the beds of navigable rivers, canals, harbours, and basins; dredging being the term applied to such operations in common with the somewhat similar one of fishing for oysters.

Some machines employed for this purpose may be compared to ploughs, harrows, or great shovels, used only to loosen the silt or deposit, preparatory to its removal either by the action of the retiring tide or by artificial scouring or sluicing. Others not only detach the sand or silt from the bottom, but also bring it above the surface of the water and discharge it into a vessel in which it may be removed to be made use of as ballast; or, when it is not wanted for this purpose, in which it may be carried to some place where it may be emptied into deep water without doing any mischief. Boats or barges for the latter purpose are frequently made with one or more large funnel-shaped openings in the bottom, through which their contents may be discharged by simply releasing a kind of trap-door.

One of the simplest contrivances for performing this operation is that known as the spoon dredging-machine, which consists of a strong ring or hoop of wrought-iron, partially edged with steel, about two feet or rather more in diameter, attached to the end of a pole thirty or forty feet long, and carrying a large bag of bullock's hide perforated with a number of small holes. This apparatus is connected by ropes and tackle with a barge or lighter, from the side of which it is let down and manœuvred in such a manner that the steel edge of the hoop cuts into the soft bottom, and scoops a large quantity of silt into the bag, which is then drawn up to the surface. The water taken up with the silt runs through the holes in the bag, which, when sufficiently elevated, is swung over the vessel and turned so as to discharge its contents. The pole is sometimes made of two pieces, capable of sliding upon one another, to adapt the machine to various depths. By this machine, which is commonly worked by from two to four men, the quantity of stuff raised in a tide from a depth of from two and a half to three fathoms, may, with a tolerably favourable bottom, range from twenty to sixty tons.

The bucket dredging-machine is adapted for performing the operation on a much more extensive scale, and with the aid of inanimate power. It was, indeed, originally worked by men, and has been worked by the power of horses walking in a circular path in the boat, but neither of these plans is eligible, and, without the steam-engine to work it, the advantages of this form of machine are questionable. The distinguishing part of this machine is a long massive framework with a wheel at each end, over which a series of endless chains, or a band formed by two or more chains laid side by side, is placed, so that by turning one of the wheels the whole chains are set in motion. Attached to the chains is a series of iron buckets, edged with steel, and perforated with numerous small holes. This framework, with its chain of buckets, is attached by one end to supports elevated above the vessel, while the other end, which is suspended by adjustable tackle, dips obliquely into the water. In some cases the bucket-frame is mounted outside, but parallel with, the vessel to which it is attached; but another arrangement is occasionally adopted in which the hinder part of the vessel is divided by an opening in the line of the keel, sufficiently capacious to allow the working of the bucket-frame within it. By means of the tackle attached to its lower end the bucket-frame is let down until it reaches the bottom, when, the steam-engine being set to work, the chain of buckets begins to perform its circuit, by which every bucket is, in succession, made to scoop up a quantity of silt, which it carries up to the top of the oblique frame, the water running away through the holes in the bucket as it proceeds. On reaching the wheel at the upper end of the frame the bucket assumes an inverted position, and consequently pours out its contents into a barge which is brought by the side, or under the stern of the vessel, to receive them, after which it descends on the under side of the frame to be refilled. In the new edition of the 'Encyclopædia Britannica,' is a long article upon 'Dredging,' illustrated by very detailed engravings and descriptions of a large steam dredging-machine, in which the peculiarities required in the construction of steam-engines for such use are minutely explained.

DRILL. A tool used by artificers in wood, stone, or metal, for the purpose of boring holes, by means of a sharp chisel, to which a rotary motion is communicated either through a handle cranked so as to allow the power of the workman to be applied directly; or through a cord, which being moved horizontally backwards and forwards causes the vertical chisel to revolve alternately in the direction of the movement. The former class of drills having usually a moveable stock or handle, are known by the name of *stock-drills;* the drills which are driven by horizontal cords are known by the name of *bow* or *fiddle drills.* In machinery and engineering works the drills are almost always driven by the gearing of the factory. The chisel end of the drill has a sharp projecting point in the centre; and the two halves, respectively on the sides of this point, are made with their cutting edges in opposite directions.

When drills attain considerable dimensions, it is necessary to modify their forms, and they then pass into the category of boring tools.

DRILL, the course of instruction in which the soldier is taught the use of arms and the practice of military evolutions.

DRILL HUSBANDRY. [DRILLING.]

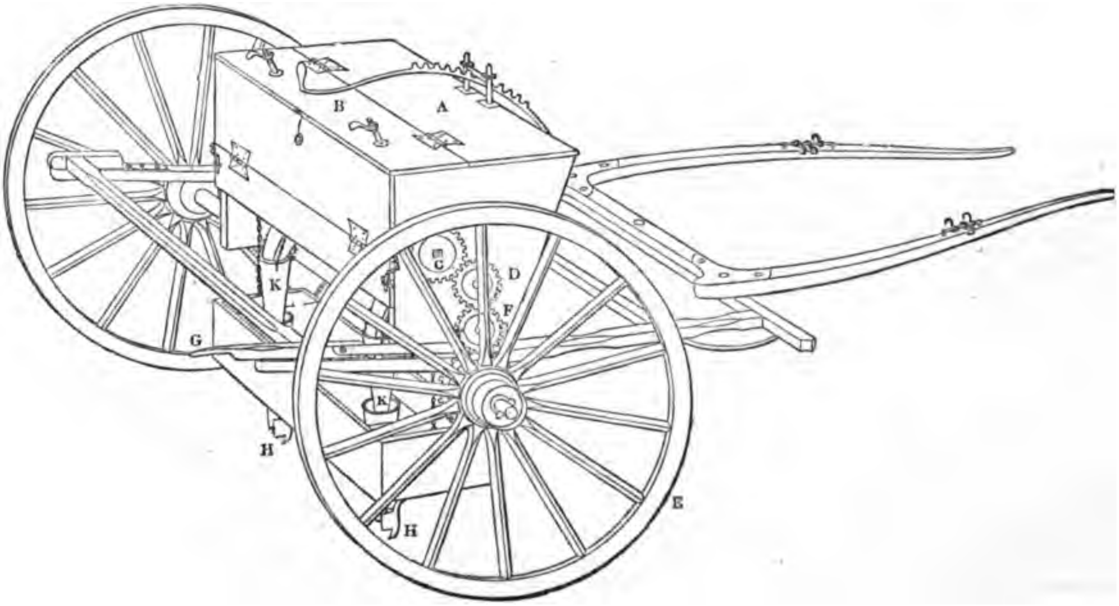
DRILLING is a mode of sowing by which the seed is deposited in regular equidistant rows, at such a depth as each kind requires for its most perfect vegetation. It has been practised by gardeners from time immemorial, and from the garden it has gradually extended to the field. In those countries where maize or Indian corn is extensively cultivated the seed is always deposited in rows; and during the growth of the plants the soil in the intervals is repeatedly hoed and stirred to a considerable depth, as is likewise the practice in vineyards. This cultivation not only keeps the land free from weeds, but by allowing the dews and the influence of the atmosphere to penetrate into the earth, greatly encourages the vegetation and growth of the plants.

It was no doubt from observing the effect produced by stirring the soil that Jethro Tull and his followers adopted the theory, that finely-divided earth formed the chief food of plants; and this led to the adoption of the row culture for every species of plant, and horse-hoeing the intervals, from which the practice obtained the name of the horse-hoeing husbandry. This was at one time thought so important a discovery as to be called the new husbandry, which was expected by its most zealous supporters entirely to supersede the old methods.

The system of Tull, as properly understood, has been long proved to have been founded on erroneous principles. But the advantage of sowing the seed in rows or drills has stood the test of experience; and the drill husbandry, by combining the advantages of continued tillage with those of manure and a judicious rotation of crops, is a decided improvement on the old methods of sowing all seeds broad-cast. The crops which are now most generally drilled are potatoes, turnips, beans, peas, beet-root, cole-seed, and carrots; and in general all plants which require room to spread, whether above or under the ground. The distance between the rows in these crops is generally such as to allow the use of a light plough or horse-hoe to be drawn by a horse between them without endangering the growing plants. The most common distance is twenty-seven inches, where the row culture is practised in its greatest perfection, which is in the north of England and in Scotland. The Northumberland mode of cultivating turnips, which is adopted by all farmers in moist climates, and seems to have decided advantages, consists in placing the manure in rows immediately under the line in which the seed is to be drilled, and keeping the intervals in a mellow and pulverised state by repeated stirring. In this mode of sowing, the seeds vegetate more rapidly, and are sooner out of danger from the fly, and the crop is more certain as well as heavier. Should the turnips fail, which with every precaution will sometimes happen, the land has had the benefit of a complete fallow, and is well prepared for any other crop.

The instrument used for sowing turnips and other seeds in single rows is sometimes a small light wheel-barrow, which a man pushes before him; hence called a drill-barrow. It has a box in which the seed is put, with a slide to regulate the quantity. This is allowed to fall on a wooden or metal cylinder below. In the circumference of this cylinder are several cavities where the seed lodges, and is carried down into a tin funnel below; the remainder is prevented from falling through by small brushes in which the cylinder turns. The motion is communicated from the wheel which runs on the ground to the cylinder by means of a chain on two pullies placed on the axes of the wheel and cylinder.

The improved Northumberland drill, of which a figure is annexed, is a more perfect as well as more complicated instrument. It is supported on two wheels, and drawn by a horse. It sows ground bones, ashes, rape-cake, or any other dry manure at the same time with the seed. The body of the drill consists of two boxes, A and B, divided by a partition between them, and each again divided into two by another partition at right-angles to the first. In the box A is put the manure, in B the seed. Iron slides are fixed in each compartment to regulate the supply of seed or manure. In the lower part of the boxes, and just before the opening, which is regulated by the slides, are two cylinders, one for the box A and another for B. On the cylinder in A are fixed shallow cups with short stems, which dip in the bones and carry a certain quantity over the cylinder as it turns, which falling in the funnels K K is deposited in the furrows made by the coulters H H. The cylinder in the box B has projecting pieces of iron, with a small cavity in each near the end, which takes up a very small quantity of seed, and discharges it in the same manner into the two funnels K K. On the axis of the wheel E is a toothed wheel, which turns a small wheel D on the axis of the cylinder in A, and this turns another wheel C on the axis of the cylinder in B. As these two wheels move towards each other, the two cylinders turn in contrary directions, which is a convenience in throwing the seed and the manure into the funnels K K at the same time. The wheel F may be lifted up by means of a lever G, and then the cylinders do not revolve. There are various other contrivances which cannot well be explained without a more detailed figure of the different parts.

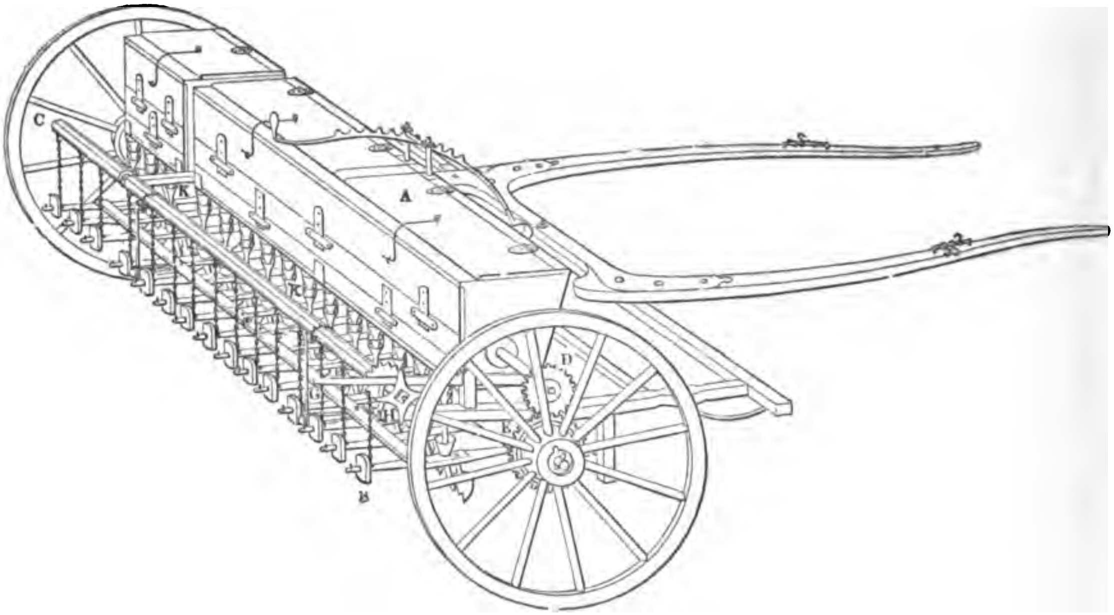


Northumberland Turnip Drill, drawn from one manufactured by Messrs. Cottam and Hallen, Winsley Street, Oxford Street, London.

In some districts there is still a prejudice against the use of the drill even for turnips. On the whole, however, drilling in the Northumberland method seems to be the best practice, and is adopted very generally by all scientific farmers.

On light friable soils, drilling the seed is very generally adopted. There is a neatness in the appearance which recommends it to the eye; and machines have been so improved, that the seed is sown more regularly and is better covered than it could possibly be by the best broad-cast sower followed by the harrows. In very stiff heavy soils, and in moist seasons, it is not so practicable to use the drill. It is sometimes impossible to get the land sufficiently dry and pulverised to allow of drilling to advantage; and when the land is wet the tread of the horses would greatly injure it. If wet clay soils were more generally underdrained, they might be rendered so dry and friable that the drill could be used at all times.

In poor sandy and gravelly soils where bones have been found of so great advantage as a manure, drilling is the only mode by which the bones and the seed can be sown in contact with each other; an important circumstance. When the ground has been well prepared and laid into stitches of a convenient width, a whole stitch may be drilled at once, with so much regularity, that an instrument with as many hoes as there are drills, and of the same width, may be drawn over the land to stir all the intervals, without danger of injuring the plants. This requires great practice and attention; but it may be considered as the perfection of the drill system. Where drilling seed is generally adopted, and the farms are not so large as to make it prudent for the occupier to purchase expensive instruments, drilling is become a separate profession. An industrious man with a small capital buys improved drills, and undertakes to drill the seed at a certain price per acre. The farmer finds horses and seed, and the driller finds the machine, and attends to the management of it himself. By constantly doing the same thing he becomes very expert; and in a neighbourhood where there are many small occupiers, a good drilling-machine, which costs from 30*l.* to 50*l.*, procures the owner a very good livelihood during the whole season of sowing; and if the instruments for hoeing were more generally used, the profession of a hoer of land might be advantageously united to that of the driller. Corn is generally drilled at the distance of eight or nine inches; and a machine which drills twelve rows will cover a stitch ten feet wide. Some prefer the rows to be nearer, but in that case the hoeing is not so easily performed with a machine, and it is done by hand. The most improved machines for drilling are made by most of our agricultural machine-makers—they are called Suffolk drills, from the county in which they originated—sowing from ten to fifteen rows at once. The description of the Northumberland turnip-drill will make the construction of Cook's drill more easily understood. In the annexed figure the box for sowing manure is not added, as it is in the Northumberland drill. The drill is supported on a frame and two wheels. The box A, which holds the seed, lets it down gradually into a lower part, in which the cylinder, which has the small cups fixed to its circumference, is turned by the wheel D. By means of the lever G this may be raised so that its teeth are freed from those of the wheel E, and the motion of the cylinder is stopped. The coulters which make the drills are each fixed to a lever, at one end of which, B, a weight is fixed to press the coulter into the ground. Each coulter has a separate lever, so that it adapts itself to all the inequalities of the soil. A chain proceeds from the end of each, and may be wound round a cylinder C by turning the handles fixed to it at H, where there is also a racket-wheel to prevent its unwinding. The intent of this is to raise all the coulters out of the ground, when the drill is not intended to act, or is moved from place to place. When the drill is used, the box A is filled with seed, and the slide in it so adjusted as to supply it regularly; the lever G, which was fixed down, is raised, and the wheel D connected with the wheel E. As the horses proceed, the cylinder turns, the cups take up the seed, and throw it into the funnels K K, which conduct it to the drill behind the coulter. A light harrow, or a bush-harrow, follows, which covers the seed. In very loose soils the roller completes the operation. These figures may suffice to indicate the general form and arrangement of these machines, though there are many niceties of construction distinguishing those manufactured by different firms, which are not represented, and the description of which here is hardly consistent with the plan of this work.



Suffolk Patent Drill, drawn from one manufactured by Messrs. Cottam and Hallen, Winsley Street, Oxford Street, London.

DROITS OF ADMIRALTY are the perquisites attached to the office of Admiral of England (or Lord High Admiral), and belonging, when that office is vacant, to the crown. Of these perquisites the most valuable is the right to the property of an enemy seized on the breaking out of hostilities. Large sums were obtained by the crown on various occasions in the course of the war with France from the seizure of the enemy's property, most of which however was eventually given up to the public service. All such sums are now paid into the Exchequer, and the perquisites formerly belonging to the Lord High Admiral (a tenth) have been given by statute to the captors.

DROPSY, HYDROPS, a preternatural collection of watery fluid in different parts of the body. In the state of health, there is constantly poured out upon every surface, cavity and interstice of the body, a watery fluid derived from the blood and deposited by the capillary blood-vessels. [CAPILLARY VESSELS, NAT. HIST. DIV.] This fluid does not remain long where it is deposited, but by vessels appropriated to the office, termed absorbents, is soon taken up and reconveyed into the common circulating mass. As long as there is a perfect balance of action between these two sets of vessels, which is always the case in health, there is no accumulation of fluid, the exhalation and the absorption being always exactly equal. But if from any cause that balance be disturbed; if either the capillary blood-vessels pour out an unusual quantity of fluid, or if the absorbents fail to act with their accustomed energy, an accumulation of fluid must necessarily take place, and this accumulation, when it amounts to an appreciable quantity, constitutes the disease called dropsy. It follows that dropsy must always be the consequence either of increased exhalation or of diminished absorption.

The causes which lead to increased effusion are exceedingly various; but they are all resolvable either into those which produce a morbid condition of the blood-vessels, an obstruction to the free circulation of the blood, or a morbid condition of the blood itself. The morbid condition of the blood-vessels may be of two opposite kinds, either that of preternatural strength, in consequence of which their action may be so excited as to pour out an unusual quantity of fluid; or that of extreme debility, in consequence of which they may be unable to prevent a preternatural exudation of the thinner parts of the blood through their relaxed coats. These different states of the blood-vessels depend on two diametrically opposite conditions of the system, and accordingly the different species of dropsy are very generally divided into active or passive, acute or chronic, sthenic or asthenic.

Whenever an obstacle is opposed to the free return of the blood from the capillary arteries into the capillary veins, the blood accumulates in the capillary arteries, which are the exhalant vessels. By this accumulation of blood in the exhalents, either their action is increased, the consequence of which is increased exhalation; or their action is diminished and their tone destroyed, the consequence of which is equally increased exhalation. Various morbid conditions of many organs oppose a free return of the circulating blood from the capillary arteries into the capillary veins; any disease of the right side of the heart, for example, which prevents its receiving from the great venous trunks of the body the quantity of blood in a given time, which is necessary to maintain the balance of the circulation; any disease of the lungs, which prevents the lungs from receiving from the right ventricle of the heart the full quantity of blood which the heart has received from the great venous trunks; any disease of the liver, which prevents the liver from receiving by the great vein which ramifies through it, the vena portæ, the full quantity of blood which it ought to receive from the different abdominal viscera; any disease of the great blood-vessels themselves, by which the current of the circulating blood is prevented from passing freely through them. Such a disease of the heart may be occasioned by an ossification of its valves; of the lungs, by an obliteration or compression of its air vesicles, upon the walls of which the capillary terminations of the pulmonary artery are distributed; of the liver, by an induration of its substance and a consequent mechanical compression of the minute branches of the vena portæ; of the great blood-vessels, by diseases of their coats giving rise to the tumours called aneurisms, or by the compression of tumours existing in neighbouring parts, scirrhous, fatty, or watery tumours, which may have their seat in any organ, or by the compression of the great venous trunks of the system by the bulk of the distended uterus in pregnant women.

When dropsy is the result of an increased action of the capillary blood-vessels, it is considered a primary or idiopathic disease, and constitutes the sthenic, tonic, active, or acute dropsy of authors. In this case the capillaries are conceived to be in that state, whatever it may be, which constitute acute inflammation. The increased effusion, which constitutes the dropsy, is the result of that increased action, and by the effusion the inflamed state of the vessels is often removed.

This form of dropsy occurs most frequently in the young, the plethoric, and the robust. It is induced by all the causes of inflammation, such as cold, suddenly checked perspiration, suppression of any of the natural secretions and discharges, a plethoric condition of the system, a repulsion of acute diseases of the skin, &c. It has its seat most frequently in the serous membranes of the great cavities of the body, the walls of which are lined by those membranes, as those of the chest and abdomen, or of the viscera to which these membranes afford an external covering, as the brain, the lungs, the heart, the liver, and all the abdominal and pelvic viscera.

The third form of dropsy is that termed asthenic, or passive. It is so generally the consequence of some other morbid condition of the system that it is not usually considered a primary or idiopathic disease, but merely a sequent or ultimate result of some other pathological state. Its proximate cause is conceived to consist partly of a laxity of the tissues of the exhalant vessels, in consequence of which they are incapable of retaining the fluid part of the blood; and partly of an altered condition of the blood itself, in which its solid portions, namely, its albumen, fibrin, and red particles [Blood, Nat. Hist. Div.] are preternaturally diminished, and its serum proportionally increased. The state of the system in which this form of dropsy usually comes on, and the causes which most frequently and obviously induce it, are supposed to conduce equally to this morbid state of the containing vessels and the contained blood. The state of the system in which it comes on is that of extreme debility, however induced; but its ordinary exciting causes have so obvious and great a tendency to exhaust the vital power, that they are usually denominated debilitating causes; such are fever, whether intermittent or continued, exanthematous or typhus, long continued and excessive evacuations, whether of natural discharges, or of preternatural effusions of blood, deficient or unwholesome diet, diseases of the digestive organs, by which the due assimilation of the food is prevented, intemperance in the use of intoxicating liquors, whence drunkards of all kinds, and especially dram-drinkers, so commonly, nay, almost invariably, die of dropsy.

All the acute inflammatory and febrile symptoms so characteristic of the other forms of dropsy are of course absent in this. The skin, instead of being hot, is often unusually cold; the pulse, instead of being full and hard, is weak, small, unequal, and rapid; the contraction of the heart is so feeble that slight causes often completely arrest its action, and render it incapable of carrying on the circulation, whence the patient drops down dead instantaneously, perhaps on endeavouring to walk down stairs, or to move from one chair to another; the muscles in general are flaccid, all the movements are weak, irregular, and uncertain, and all the actions of the system exceedingly feeble.

It is more especially this last form of dropsy which is induced by a morbid change in the constitution of the blood, namely, an increase in the proportion of its serum. An unusual quantity of water taken into the body, and not carried off by the excretory organs, may possibly give rise to such a condition of the blood, and accordingly it is said that suddenly drinking large draughts of very cold water has been immediately followed by dropsy, probably from the cold producing a constriction of the excretories; in consequence of which they are unable to carry off the water as it flows into the mass of blood and thus to maintain its proper constitution. A preternatural abundance of the more fluid parts of the blood may also accumulate in the circulating mass by a suppression or diminution of the ordinary aqueous excretions. Hence the influence of a cold and moist atmosphere in inducing dropsy; and the highly important influence of diseases of the kidneys in producing the disease. It is found that there are several different diseases of the kidneys of which dropsy is the ordinary result. It is the office of the kidney to remove from the blood a large proportion of its fluid parts; it is an excreting and depurating organ of the greatest importance. Any disorder of it which interferes with the performance of its function may therefore occasion an accumulation of the watery particles of the blood, and thus give rise to dropsy; and it is actually found that when the secretion of the urine is suppressed, the watery portion of the blood is often poured into some of the internal cavities. [Kidneys, Diseases of.] Moreover, large abstractions of blood are frequently followed by dropsy, because the albumen, the fibrin, and the red particles which constitute the solid parts of the blood, are not so easily renewed as the serum, and the superabundant serum readily passes off by the exhalants preternaturally relaxed by the debilitated state of the system induced by the bleeding.

The parts of the body in which the dropsical effusions usually collect are the cavities of the cranium, chest and abdomen, and the interstices of the cellular tissue diffused over the whole body, and forming a constituent element of every organ.

The dropsical fluid itself consists for the most part of the serum of the blood; but its sensible properties and its chemical constitution vary exceedingly according to the form of the disease and the condition of the capillary vessels at the moment the effusion takes place. If the vascular action have been great, the fluid is yellow or straw coloured like whey, and is more or less turbid, and contains minute particles of albumen and fibrin. If, instead of excited vascular action, the effusion have been the consequence of an altered condition of the blood, the fluid is dark-coloured and turbid, probably from the admixture of the red particles of the blood. If the effusion have taken place very slowly in consequence of the operation of some cause progressively but not rapidly impeding the circulation more and more, the fluid is almost colourless and nearly destitute of animal matter. If the fluid have been long retained in the cavity containing it, it may be of all colours and consistence, and its sensible properties may be infinitely diversified and these diversities are apparently increased by the admission of the external air to the cavity in consequence of the artificial removal of the fluid by the operation called tapping.

There are many diseases of which dropsy is the sequent, and the dropsy induced in this indirect mode is called secondary, consecutive, symptomatic, or passive, in contradistinction to its primary acute and active forms. The diseases which precede dropsy as their ordinary consequent have their principal seat in the heart, and its great vessels, in the lungs, the liver, the spleen, the kidneys, the uterus, and the ovaria. When dropsy is the consequence of disease of the heart, the signs of disease of the heart commonly long precede the appearance of the dropsy. The diseases of the heart which most commonly give rise to dropsy are passive dilatation of its muscular parietes and ossification of its valves, the existence of which may be ascertained with tolerable certainty both by certain signs which are pathognomonic of these organic changes, and by auscultation. When dropsy is the consequence of disease of the heart, the effusion is commonly indicated first by swelling of the face, especially beneath the eyelids, and next by swelling of the feet and ankles, and of the hands and arms, particularly of the left. As in the progress of the disease the effusion collects and accumulates in the cavity of the thorax, or in that of the pericardium, it is denoted by a peculiar train of symptoms. [Hydrothorax; Heart, Diseases of.] The respiration is always more or less embarrassed; the horizontal position uneasy, and often impossible; the pulse, which is seldom or never natural, is very variously affected. Whenever there is a watery swelling of the face, hands, arms, or ankles, with an impaired state of the constitution, the consequence of protracted ill health, and without manifest disease of the lungs, it may be certainly inferred that there is a disease of the heart. The dropsy which results from disease of the heart is very often completely removed by appropriate remedies. The effusion often recurs indeed, and is again removed, and this successive recurrence and removal of the affection takes place indefinitely until the cardiac disease, on which the effusion depends, reaches a point which is no longer compatible with life.

Diseases of the coats of the great blood-vessels constituting aneurism, concretions within their cavities, or tumours of neighbouring parts, pressing upon their trunks, and obstructing the passage of the blood through their canal, are frequent causes of consecutive dropsy. Inflammation of the pleura lining the cavities of the chest, inflammation and congestion of the lungs, the consolidation or hepatisation of the substance of the lungs, and the obliteration of the air-vesicles by the deposition of tuberculous matter, may give rise to effusion either into the cavity of the chest, or into the cellular tissue forming the parenchyma of the lungs, or into the cellular tissue diffused over the whole body.

Inflammation of the liver, generally of a slow or chronic nature, leading to a deposition of adventitious matter in its substance, and the consequent enlargement of the organ and the consolidation of its tissue, is a common cause of dropsy, occasioned by the obstruction to the circulation through the vena portæ, the effusion being in this case often confined to the cavity of the abdomen.

The spleen, which consists of a congeries of blood-vessels, and which is very apt to be enlarged and obstructed, may occasion effusion into the abdomen in the same manner as disease of the liver.

The kidneys are subject both to functional and organic diseases, which are followed by effusions into all the cavities, in consequence of the failure of these organs to remove from the common mass of blood the superfluous and noxious principles which it is their office to eliminate.

Dropsical effusions are often poured into the uterus and ovaria, in consequence of primary disease in these organs; at other times tumours are formed within or attached to them, which press upon and compress the trunks of neighbouring blood-vessels, and thus occasion dropsy by a mechanical obstruction to the circulation of the blood.

Dropsy is always a formidable and often a highly dangerous disease. Its acute forms, though attended with the most urgent symptoms, are in general less unfavourable than most of its chronic forms, because in the former, though the disordered actions may be very intense and dangerous, yet they are more under the control of remedial agents, and they often do not depend on any irreparable vice of the constitution, whereas the latter are the sign and the result of deep-seated and surely advancing disease. Of course the prognosis in any particular case must entirely depend on the seat and nature of the disease of which it is the sequent.

There is no disease which requires a more varied treatment than dropsy, because, like fever, dropsy may exist in, and be essentially connected with, diametrically opposite morbid conditions of the system. Dropsy may depend on a state of the system, for the removal of which all other remedies will be tried in vain unless their application be preceded by a decided abstraction of blood: dropsy may depend on a state of the system in which the abstraction of the smallest quantity of blood may prove almost instantaneously fatal; in the former case stimulants and excitants invariably increase the intensity of the disease; in the latter they are indispensable to the preservation of life. On the clear discrimination of these two different states of the system, and the two different classes of disease to which they give rise, and on the sagacious detection of the different shades by which they may appear to be blended with and lost in each other, the successful treatment of dropsy mainly depends.

(PERITONITIS; HEART, DISEASES OF; PLEURITIS; LIVER, DISEASES OF; OVARIAN DROPSY; HYDROCEPHALUS.)

DROWNING, the state of asphyxia [ASPHYXIA] produced by the immersion of the body under water. When the warm-blooded animal is immersed under water, and forcibly retained there, he immediately begins to struggle violently, and uses every effort to rise to the surface. These struggles are not at first the result of pain, but of fear. It is proved by direct experiment that the obstruction to the respiration which produces pain does not come on for some time. The point of time when the painful impediment to respiration occurs is well ascertained. For the reason assigned in the article ASPHYXIA, in the space of three-quarters of a minute a violent effort is made to inspire, to expand the lungs with air, but no air can enter. Every effort to inspire is followed by a corresponding effort to expire. At each expiration a small quantity of air is expelled from the lungs, and is seen under the surface of the water in the form of bubbles; for although the water excludes the air from entering the lungs, notwithstanding the most violent efforts to inspire, yet it cannot prevent some portion of air from being expelled from the lungs by the violent efforts to expire. The ultimate result of these repeated and violent expirations is greatly to diminish the bulk of the lungs, and to bring them to the utmost degree of collapse to which it is possible to reduce them by any voluntary or instinctive efforts which the animal is capable of making.

When a human being is drowned by accident, if the fall has been from a considerable height and the water is not of very great depth, the body is precipitated to the bottom of the water; it then quickly rises to the surface, partly because the specific gravity of the body, when the lungs are full of air, is less than that of water, and partly because the body is rendered still lighter by the air, always amounting to a considerable quantity, which is collected and retained in the clothes. If the person be not able to swim, he generally struggles violently, and probably screams; by these efforts the lungs are partly emptied of the air they contained, the comparative weight of the body is increased, and consequently it again sinks to the bottom, but it soon again rises, and this alternate rising and sinking may occur several times in succession. Whenever the body comes to the surface and the mouth is above water, the painful impediment to respiration produces an instinctive effort to inspire, and a hurried gasp is made to obtain air. But often the mouth is not sufficiently above the surface of the water to obtain air without respiring a quantity of water along with it; but the quantity of water received in this manner is never great, probably not more than is expelled by the cough excited by the irritation of the glottis in consequence of the contact of the water and by the subsequent expiration. Every instant the body remains in the water, for the reasons immediately to be assigned, the powers of sensation and of voluntary motion rapidly diminish, and at length, perfectly insensible and motionless, it remains at the bottom of the water, where, if wholly undisturbed, it continues until the disengagement of various gases in the progress of putrefaction renders it again specifically lighter than water, and brings it once more to the surface.

The change in the system produced by continued submersion, the consequent suspension of respiration, and the necessary extinction of life, are all referrible to one pathological condition, namely, a change in the nature of the blood. The water prevents any portion of air from entering by the trachea to the air vesicles of the lungs; consequently no air comes in contact with the venous blood contained in the capillary branches of the pulmonary artery which are spread out upon the walls of these air vesicles; the venous blood which flows to the lungs is therefore incapable of being converted into arterial blood, whence the lungs can deliver to the left side of the heart only venous blood to be sent out to the system. As the circulation goes on, all the arterial blood in the body is at length converted into venous, and flows into the great venous trunks of the system, by which it is returned to the right side of the heart, and thence to the lungs, where it undergoes no change, but remains venous. These currents of venous blood, and of venous blood only, are successively sent out to the system. But venous blood is incapable of maintaining the action and vitality of the brain and spinal cord, of the heart, of the voluntary muscles, or of any organ of the body, and consequently, when nothing but venous blood circulates in the system, the death of all the organs is the sure and quick result, and the organs die in the order and mode already described. [ASPHYXIA.]

Taking the average of a great number of experiments, it is found that when an animal is forcibly and continuously held under water, the blood in the arteries loses its vermilion colour, and begins to grow venous in the space of three-quarters of a minute. In one minute and a quarter it is obviously dark. In one minute and a half, no difference can be distinguished between the blood in the arteries and the blood in the veins; consequently, in an animal that is submersed and that never rises to the surface, the system is brought completely under the influence of venous blood in the space of one minute and a half, and though the body should remain under water half an hour, the blood does not become sensibly darker, because it can only be completely venous.

Circumstances may make a few seconds difference in regard to the point of time when these phenomena take place. If, for example, an animal be submersed at the instant of expiration, the colour of the blood is lost somewhat sooner than when it is submersed at the instant of inspiration, and if the animal be much alarmed and struggle violently, the change takes place with greater rapidity; but the difference from any cause of this kind never amounts to more than a few seconds. Age however is capable of effecting a more remarkable difference. It is proved by numerous and accurate experiments that the younger the animal the longer it can live when deprived of air by submersion. If, as is commonly the case, an adult warm-blooded animal be irrecoverably dead in the space of four minutes after complete and continuous submersion, an animal of the same species only a few days old will live twelve minutes. A pup will live considerably longer than a young dog, a young longer than a middle aged dog, and a middle aged longer than an old dog.

Sensibility and the power of voluntary motion are diminished the moment the arterial blood begins to lose its vermilion colour; an animal is completely insensible, and has wholly lost all power of voluntary motion, that is, it is in a state of apparent death, as soon as the arterial blood is completely venous. In one minute and a half, then, after complete and continuous submersion, animal life is completely extinguished. But by the prompt and vigorous use of the appropriate remedies, recovery from this state is possible; because the organic functions go on for a considerable period after apparent death, and death is not real until the organic functions have wholly ceased. Nevertheless, though the organic functions may continue for an indefinite period after the animal functions are extinguished, from ten minutes to half an hour, or more, yet, in no instance in which the experiment has been fairly tried has any adult warm-blooded animal that has been completely and continuously submersed for the space of four minutes been capable of resuscitation, though all the means of restoring animation may have been instantaneously and most actively and judiciously employed. Accordingly it is found in practice that the immediate and vigorous use of the best means for restoring animation often fail when the person has not been in the water more than four minutes. In general, however, if the body has not been in the water longer than from five to eight minutes, the prompt and persevering use of the proper means for restoring animation will succeed; no doubt, because in some one of or in all the times that the body has come to the surface air has been obtained and conveyed to the lungs in the hurried gasp instinctively made at these moments. Still it is exceedingly rare that persons are recovered who have been in the water fifteen minutes; occasionally however animation is restored after a submersion of twenty minutes, or even half an hour; and apparently authenticated cases are on record in which resuscitation was accomplished after the body had been in the water for three-fourths of an hour. In these cases, circumstances must have favoured the occasional inspiration of air; it is utterly impossible that life can have been maintained so long unless the individual had breathed at intervals during the time; and as none can tell what circumstances may have occurred favourable to the inspiration of air, it is an imperative duty in all cases to resort to the proper means for restoring animation with all the promptitude and energy possible.

When a person who has been drowned, who was previously in a state of sound health, is taken out of the water, the appearances presented by the body are the following:—

The whole of the external surface is cold; the colour of the skin is pallid, excepting in the parts where it is livid rather than pallid, as in the face, which is always either entirely pale or slightly livid. The eyes are half open, and the pupils much dilated. The mouth and the nostrils contain a great deal of frothy fluid. A large quantity of the same kind of fluid is contained in the trachea, the bronchial tubes, and the air vesicles of the lungs. The tongue is protruded between the teeth, and approaches to the under edge of the lips. The whole head is sometimes much swollen, and the features occasionally present the appearance of those of a person who has died from apoplexy; and this is said to be particularly the case with those who have fallen into the water in a state of intoxication. It is usually considered as a sign that a person has been drowned while living, and that the body has not been thrown into the water after death, that the ends of the fingers are excoriated, and that there is a collection of dirt or sand under the nails, appearances resulting from the efforts which the drowning person has made to avert his impending fate; but if the water be deep, no appearance of this kind is present, because the power of struggling is over before the body touches the ground, and a person in the state of intoxication, who falls into deep water may expire without the power to make a single effort to save himself.

With regard to the internal organs, the heart and its great blood-vessels are always found preternaturally loaded with dark-coloured blood, sometimes to such an extent that the heart seems completely to fill the bag of the pericardium. This accumulation of black blood is always on the right side of the heart, which usually contains somewhat more than double the quantity contained in the left cavities.

The lungs are invariably very much reduced in volume, and are exceedingly loaded with black blood. Both the pulmonary arteries and veins are likewise distended with black blood.

The substance of the brain is of a darker colour than natural, and its vessels are commonly turgid with black blood; but sometimes the turgescence of the cerebral blood-vessels is not in proportion to the accumulation of blood in the other organs.

There is always a quantity of water mixed with frothy matter in the trachea and bronchi. Occasionally this frothy matter is mixed with blood. The quantity varies a good deal in different cases, but it is never very great. At one time it was thought to be so great as to be the cause of death in drowning. It was conceived that the water flows into the lungs by the trachea in such abundance as to occasion asphyxia. The controversy which was long agitated on this point is now set at rest by numerous and accurate experiments, which demonstrate that only a very inconsiderable quantity of water enters the trachea, and never sufficient to occasion death.

A similar controversy prevailed on the question whether water enters the stomach, which is now equally decided in the negative. It is proved beyond all doubt that no water passes into the stomach, or at least that no quantity enters it capable of contributing in the slightest degree to the fatal event. The establishment of this point is important, because the contrary notion had led to the adoption of most pernicious practices. With a view of evacuating the water supposed to be accumulated in the lungs and stomach, the bodies of the drowned, when taken out of the water, were held up by the heels, rolled on barrels, and subjected to other practices calculated rapidly to extinguish any remaining spark of life; and though the notion which led to these absurd practices is exploded, the practices themselves continue.

The proper remedies for the recovery of the drowned are few and simple. The body, placed on a bed-chair, should be removed to the receiving-house or any place where the conveniences required may be most easily obtained. The wet clothes should be stripped off as rapidly as possible, the body well dried and surrounded by warm air, if it can be readily procured, by the portable warm-air bath, of which there ought to be one at every receiving-house. At first the heated air should only be a few degrees above the temperature of the body, and the heat, which ought always to be ascertained by a thermometer, should be subsequently increased with caution. The body being thus surrounded with warm air, artificial respiration should be performed without the delay of a moment, and this should be assisted by electricity applied at first in the form of very gentle shocks.

By the application of heat the capillary blood-vessels are stimulated to action, the determination of blood towards the external surface of the body is favoured, and the internal organs are thus relieved of their oppressive load. By artificial respiration the cavity of the chest is enlarged, the collapsed state of the lungs is removed, and atmospheric air, the great agent needed for the decarbonisation of the blood, and on the want of which all the dangerous phenomena of drowning depend, is transmitted to the lungs and brought into contact with the venalised blood. By electricity the organs which carry on the mechanical part of respiration, that is, those which alternately enlarge and diminish the capacity of the thorax, are roused and excited to resume their natural action. There are some few other useful auxiliaries, but so important and efficacious are these three powerful agents, when judiciously and perseveringly employed, that they may be considered as the only remedies worth regarding. But unfortunately they are as potent for evil as for good. A slight mismanagement of any of them may utterly destroy that life which the delicate and skilful use of it would have reanimated.

A plan of treatment of the drowned was proposed by the late Dr. Marshall Hall to the Royal Humane Society in 1856. Many instances have been recorded of the benefit of this plan, in cases of suffocation and drowning, even after the heart had entirely ceased to beat. We give this plan in Dr. Marshall Hall's own words:—

1. Treat the patient instantly on the spot, in the open air, except in the severe weather, freely exposing the face, neck, and chest to the breeze.

2. Send with all speed for medical aid, and for articles of clothing, blankets, &c.

3. Place the patient gently on the face, with one arm under the forehead, so that any fluids may flow from the throat and mouth, and without loss of time

I. *To excite Respiration.*

4. Turn the patient on his side, and
   a. Apply snuff or other irritant to the nostrils.
   b. Dash cold water on the face, previously rubbed briskly until it is warm.

If there be no success, again lose no time; but,

II. *To imitate Respiration,*

5. Replace the patient on his face (when the tongue then will fall forward, and leave the entrance into the windpipe free); then

6. Turn the body gently, but completely *on the side and a little beyond* (when *in*spiration will occur), and then on the face, making gentle pressure along the back (when *ex*piration will take place), alternately; these measures must be repeated deliberately, efficiently, and perseveringly, fifteen times in the minute *only*. Meanwhile,

III. *To induce circulation and warmth,*

continuing these measures,

7. Rub the limbs *upwards*, with firm pressure and with energy, using handkerchiefs, &c., for towels.

8. Replace the patient's wet clothing by such other covering as can be instantly procured, each bystander supplying a coat, waistcoat, &c.

"These rules," says Dr. Hall, "are founded on physiology, and whilst they comprise all that can be done immediately for the patient, exclude all apparatus, galvanism, the warm bath, &c., as useless, not to say injurious, especially the last of these, and all loss of time in removal, &c., as fatal."

DRUGS; DRUGGISTS. The difference between drugs and chemicals is vague and indeterminate; and the professions of the chemist and druggist and apothecary are in like manner generally mixed up together in popular estimation. The rules established by the medical corporations, such as the College of Physicians, the College of Surgeons, and the Apothecaries' Company, have had much to do in producing this uncertainty. The acids, alkalies, salts, and oxides used in largest quantity, are made on a scale which requires complete manufacturing arrangements, with large furnaces, stills, and other apparatus. Such is the case in relation to sulphuric and nitric acids, chlorides of lime and of sodium, alum, &c.; such articles are made by manufacturing chemists, at the vast chemical works which are met with at Glasgow, Liverpool, Newcastle, Hull, and Bristol, and to some extent in the metropolis. A retail shopkeeper who calls himself a chemist and druggist is a chemist in so far as he retails, and understands the general character of, the chemicals made on a large scale by others; while he may be regarded as a druggist to the extent that he understands, and sells by retail, the substances used in medicine. If he can himself prepare, on a small scale, a considerable number of the substances which he sells, it is now customary to term him a pharmaceutist or pharmaceutical chemist.

Dr. Normandy has published a work on drugs and chemicals, under the name of 'The Commercial Handbook of Chemical Analysis,' especially designed to afford aid in the detection of fraud in the manufacture of food, drugs, and chemicals. The list of articles of which the processes of adulteration, and the means of detection, are given, is very comprehensive; including not only ordinary viands and beverages, as bread, porter, tea, coffee, chocolate, cocoa, spirits, liqueurs, and wines, but the drugs used in medicine, and a great variety of miscellaneous substances. They are alphabetically arranged, for convenience of reference. "Country druggists," it has been remarked, "form a class of persons to whom this book would be very serviceable; for, although there are of course highly creditable exceptions, particularly in great provincial towns, the bulk of them are not distinguished for chemical or even pharmaceutical knowledge. Few are capable of conducting an analysis or organic research, and they are frequently imposed upon by wholesale dealers, who send them damaged or spurious drugs, which, if administered in dangerous maladies, might induce aggravation of disease, and very probably cause death."

A movement is being made towards placing under legislative control the sale of drugs, on the ground that frequent cases of poisoning occur through the ignorance or carelessness of retail druggists. The physicians, surgeons, and apothecaries have also endeavoured, at various times, to have the drug trade placed in some degree under professional control. Nothing, however, has yet been effected in this direction. In the "Medical Act," passed in 1858, the new General Council, formed to carry out the provisions of the Act, is empowered "to cause to be published under their direction a book containing a list of medicines and compounds, and the manner of preparing them, with the true weights and measures by which they are to be prepared and mixed, and containing such other matters and things relating thereto, as the General Council shall think fit, to be called 'British Pharmacopœia'; and the General Council shall cause to be altered, amended, and republished such Pharmacopœia as often as they shall deem necessary;" but there is a special clause, exempting chemists and druggists from any interference in the new Council, which represents all the physicians, surgeons, and apothecaries of the three kingdoms.

DRUM. [Dome.]

DRUM, a pulsatile musical instrument, of which there are three kinds,—the *Side drum*, the *base* or *Turkish drum*, and the *double drum*. The first is a cylinder or *shell*, formerly of wood, but now invariably of brass, on each end of which is a hoop covered with vellum or parchment. This is the ordinary regimental drum. The second is formed as the first, but of oak, on a much larger scale, and used, not in conjunction with the fifes, but as part of the regimental band. It is likewise employed occasionally in the orchestra. The third is made of copper, nearly hemispherical, covered with a strong *head* of calf's-skin, and stands on three iron legs. The double drums, or *kettle* drums as they are also called, vary in dimensions, from nineteen inches to three feet in diameter. They are always in pairs, and are tuned by means of many screws which tighten the head, to the key-note and the fourth below. The part for them is written in the key of C, and if the music be in another key, it is notified at the beginning as "drums in D," "drums in E♭." An improved method of tuning these instruments is by means of a lever operating on several hooks which act simultaneously on the head, or hoop on which the skin is strained, so that the tuning is performed at once, and with such rapidity, that a melody such as 'God save the Queen' can be performed on a single drum in a time not much slower than that usually adopted. A patent has been obtained by the ingenious mechanist (Mr. Cornelius Ward) to whom we are indebted for this useful invention.

About two years ago a brass drum of improved construction was introduced into the infantry regiments, weighing some three pounds less than the one previously in use, smaller in size and more portable, superior in tone and more easily tuned. This drum is manufactured by Messrs. Key, Rudall, and Co., Charing Cross, London. It is tuned by means of screws, instead of the old straps and ropes: the head which is beaten, called the *batter-head*, alone requires to be tuned, while the other head, which has three cords called the *snare*, drawn across its exterior surface, responds by reverberation. Messrs. Key and Co., have also invented a *skeleton side drum*, that is, a drum without any shell; it resembles a couple of tambourines with their concavities presented to each other; it is intended for indoor use, and gives the lightest character of tone.

DRUMMOND LIGHT. The difficulty of distinguishing the stations chosen for the angular points of the triangles in a geodetical survey, when those stations are many miles asunder, renders it necessary to have recourse to illuminations even in the day-time; and the late Captain Drummond, of the Royal Engineers, invented a heliostat which reflected the sun's rays in sufficient abundance to render the station which was to be observed visible. This was a plane mirror of a rectangular form and mounted on a stand with joints by which it could be fixed at any angle with the horizon. On the stand was a telescope which was capable of being moved horizontally, with the mirror, and directed to the distant station, while another telescope was directed to the sun. The adjustments of the mirror were such that, when the telescopes were directed, as has been said, the face of the mirror reflected the rays of the sun on the distant station, and illumined it sufficiently to render a mark there visible in the telescope of the theodolite by which the required angle was to be taken.

When it was required to observe the angles subtended between distant stations at night, the white or blue lights were first employed in this country; the materials being fixed, at the station, at times agreed upon by the parties employed in performing the operations: Argand lamps with parabolic reflectors, were used by the French, and subsequently by the English geodists; but a light which Captain Drummond obtained has been found to exceed in brilliancy any of the others. This is the *oxy-calcium* light, and is produced by placing a ball or disk of lime, about a quarter of an inch in diameter, in the focus of a parabolic mirror, at the station to be rendered visible, and directing upon it, through a flame arising from alcohol, a stream of oxygen gas. ('Philosophical Transactions,' 1826, p. 324.) The cistern containing the alcohol is supported on a stand, behind the reflector, and is connected by a tube of caoutchouc with the lower part of a hollow stem supporting the upright wire at the top of which is fixed the ball of lime on a level nearly with the cistern: the spirit ascends in the stem, and afterwards, through three or more tubes, to the ball. The vessel containing the oxygen gas is connected, by a flexible tube, with an orifice in a cylindrical box on the same stem, from whence it ascends through three flexible caoutchouc tubes to the ball, after passing with friction through three small cylinders. The whole apparatus is attached to a stand which carries the mirror; and adjustments are provided by which the ball may be placed exactly in the focus of the mirror. The intensity of the flame is from sixty to ninety times as great as that of an argand burner, while the expense is only about ten times as great. The lime made from chalk is preferred to any other; and such is the brilliancy, that stations above sixty miles from one another have been very distinctly visible even in hazy weather. In clear weather the light has been seen at a distance of 112 miles. On the 31st Dec. 1845, it was seen across the Irish Channel, at 3.30 P.M. from the top of Slieve Donard in Ireland, by an observer at the top of Snowdon, a distance of 108 miles in a direct line.

Captain Drummond suggested in a paper which was printed in the 'Philosophical Transactions' for 1830 (p. 383), that burning lime should be employed for lighthouses; and he proposed that instead of alcohol, hydrogen gas should be used with the oxygen gas. The gases were to proceed from separate vessels, or gasometers, and enter a chamber through a series of small apertures: the united gases were then to pass through two or three pieces of wire gauze, and issue in two streams against the ball or disk of lime. To prevent the latter from wasting too rapidly in one place it was made to revolve once in a minute; and in order to keep up a constant light, it was proposed to have an apparatus by which a number of balls might be successively made to fall in the focus of the mirror. The chief objection to this proposal (to say nothing of the impropriety of entrusting so explosive a compound as the mixed gases to the care of ordinary workmen) is the smallness of the flame, whereas dioptric instruments require a great body of flame for the purpose of producing a degree of divergence sufficient to render the duration of the flash in revolving lights long enough to be well made out; while in a fixed light with a reflector the same defect of volume eminently applies.

A light of this kind may also be employed as a signal in determining the difference between the longitudes of stations.

The *lime light*, as it is also called, has superseded the solar microscope, or rather can be used at all times instead of the sun; the oxy-calcium light is in great request for microscopes, phantasmagoria, and scenic effects on the stage, &c. There are some advantages in using the mixed gases contained in separate bags, since no safety jets, &c., should be relied on, but the danger in inexperienced hands is great. We have even known an accident occur in the lecture-room of an eminent chemist.

DRUSES, DOROUZ, a people who inhabit the chain of Libanus, in Syria, are under the government of their own chiefs, and have a religion peculiar to themselves. The vernacular language of the Druses is Arabic, though they have a tradition that they came originally from China. Although the mountaineers of Libanus in general obey the emir, or prince of the Druses, yet they are not all Druses, but the greater part of them are Christians of the Maronite communion, which belongs to the western, or Roman, church. [Maronites.] Though much intermixed, they are frequently at war with each other, and such a war was being carried on in 1859. The Druses live chiefly in the south part of Libanus, east and south-east of Beiroot, and as far south as the district of Hasbeya, about the sources of the Jordan, but a few thousands are still found about Jebel-el-'Ala, in Northern Syria, where they were formerly more numerous till expelled by the Mohammedans. At Jeir el' Ashayir, a small village of Druses, there are the ruins of a large and splendid temple, a quadrangle, 90 feet by 36 feet within, on a raised platform, ornamented with Ionic columns at the angles. Towards the east the jurisdiction of the emir extends over part of the Bekaa, or plain intervening between the Libanus and the Antilibanus. North of the Bekaa is the Belad, or district of Balbek, which is inhabited chiefly by Mussulmans, and is under a distinct emir of the sect of the Metawalis, subject to the pasha of Damascus, with whom there are frequent hostilities. The former capital of the Druses was Deir el Kamr, in a valley on the west slope of Libanus, about eight or nine hours' ride south-east of *Beiroot* (Beyrut): the town is said to have about 8000 inhabitants, partly Druses and partly Christians. The town is built in the Italian fashion, and is said to resemble a second-rate country town of Italy, but it suffered greatly in the war of 1846. The land around the town displays in a marked manner the industry and skill of the inhabitants, as it is cultivated with the greatest care, and an almost barren soil made highly productive. The emir used to reside at the palace or castle of Bteddin, about one hour's ride from Deir el Kamr, which is still kept in good order, though not used for his residence. Some of the apartments of the palace are described as very handsomely furnished, paved with marble, and adorned with rich folding draperies and divans, the walls inlaid with ivory and gilding, and adorned with passages of the Koran and Scriptures in Arabic, in large embossed gilt characters, enclosed in panels of various size. The emir Beshir, as he was called, whom Captain Light saw in 1814, was described as an elderly man of an intelligent and prepossessing appearance, and said to be very regular and abstemious in his habits. He had come to the sovereignty by defeating several competitors, whom he imprisoned and put to death. (Light's 'Travels.') In 1822, having supported the rebellious Abdallah, pasha of Acre, he incurred the displeasure of the Porte, and took refuge in Egypt, but returned soon after by the mediation of Mehemet Ali, the pasha of Egypt. At the time of the occupation of Syria by Ibrahim, Mehemet's son, the Druses joined him at first; they afterwards quarrelled with him; but they were beaten, and peace was ultimately restored. Up to 1840 the emir Beshir remained faithful to the Egyptians, but as he did not separate himself before the restoration of Syria to the Turks, he was deprived of his dignity; he then withdrew, first to Malta, and afterwards to Constantinople, vainly soliciting his restoration. Kassim was named emir Beshir in his stead. The Druses and the Maronites again commenced hostilities between themselves, of which the Turks took advantage, in order to weaken their power. The civil war endured for upwards of two years, when the Porte displaced the emir el Kassim, and appointed Omar Pasha as administrator. His arbitrary conduct caused the Druses to unite with the Maronites, and both broke out into insurrection against the Turkish dominion. The Christian powers interfered, Omar Pasha was recalled, and a Turkish kaimakan appointed. This produced a partial suspension of hostilities, but the Druses still continued to acknowledge only their own chief, and in this state the country yet continues; while the Maronites sometimes have a chief of their own, and sometimes submit to the chief of the Druses. The emir has under him several subordinate emirs, or local chiefs, in various districts of the mountains, some of whom are Druses and others Maronites. As the whole population is armed and trained to the use of the gun, it is said that in case of need the emir can collect in a very short time 30,000 men; but this must be only part of the individuals capable of bearing arms, as the Maronite population alone is said to be more than 200,000, and the Druses are stated by Mr. Paton ('The Modern Syrians,' 1841), to be about 70,000.

The Druses are divided into two classes: the Akkal and the Jukhal, the initiated and the ignorant. No religious duties are imposed, but their creed includes a belief in the unity of God's five superior spiritual messengers, including Hamza and Christ; in the transmigration of souls; in the triumph of their religion; and in the renunciation of the seven points of Islamism. The Akkals make an assumption of superior morality; they neither smoke tobacco nor drink spirituous liquors; they use no bad language; and profess to abhor falsehood, but do not scruple to exercise equivocation. They meet for religious purposes every Friday evening at an hour after dusk, when they read extracts from their religious books. All the Druse women are taught to read and write. The penalty of death, it is said, would be incurred by any one who should turn Mussulman or Christian. They make no proselytes. As to the nature of their secret doctrine, we have an account of it in De Sacy's 'Chrestomathie Arabe,' vol. ii.; but how far it can be relied upon is still a question with some, as it depends upon the authenticity of the books from which De Sacy has extracted it. It is doubtful whether in fact there are any secret doctrines. It appears however pretty certain that the Druses are, or were originally, disciples of Hakem biamr Illa, the sixth Fatimite caliph of Egypt, who in the 11th century proclaimed himself to be an incarnation of the Divinity, and who established a secret lodge at Cairo, divided into nine degrees, the last of which taught the superfluousness of all religions, the indifference of human actions, &c. (Von Hammer, 'Geschichte der Assassinen,' 1818.) The Assassins themselves were a derivation of Hakem's sect, which was itself an offshoot of the great schism of the Ismaelites, a remnant of whom still exists in Syria, in the mountains east of Tortosa, near their ancient stronghold Maszyad. Hakem disappeared, probably by assassination, in one of his solitary walks near Cairo, but his disciples expect his return, when he is to reign over the world.

The Assassins, however, now called Ansayrii, are distinct from the Druses, with whom there are frequently hostile conflicts, though the emir Beshir has a nominal sovereignty over them. All agree, however, in saying that all these sects, Druses, Maronites, and Ansayrii, are industrious, brave, and hospitable: their country is a land of refuge from Turkish oppression; they pay few taxes, as the emir has lands or domains belonging to him, from which he draws his chief revenue. Silk is the staple article for exportation, by way of Beiroot. The mulberry, the vine, the fig, and other fruit-trees, are reared in the lower ridges of the Libanus, while the higher range affords good pastures. Cotton is also cultivated and manufactured. The plains, especially the Bekaa, produce corn. There are a number of convents scattered about the mountains; there is a Maronite college for the study of Syriac at Aain el Warka, and another for the Melchite students at Deir el Mhalles. Burckhardt, who crossed the Libanus in different directions, gives the names of many towns or villages inhabited by Druses and Maronites, some of them considerable places, such as Hasbeya, with 700 houses; Zahle, in the Bekaa, with 900, this is now the residence of the emir Beshir, or chief; Shirrei, near Tripoli, &c. The Druses dress differently from the Maronites: the men wear a coarse woollen beneesh, or cloak, black, with white stripes, thrown over a waistcoat, and loose breeches of the same stuff, tied round the waist by a sash of white or red linen with fringed ends; their turban is swelled out from the head into a shape resembling a turnip, and flat at the top. The women wear a coarse blue jacket and petticoat, without any stockings, and their hair plaited and hanging down in tails behind. When they dress they put on their head the Takeel, a hollow tube of silver or tin, from six to twelve inches high, shaped like a truncated cone; this cone is worn even by young female children whom Mr. Paton says he has seen adorned with it while sleeping in bed. Over this cone when the ladies are full dressed is thrown a white piece of linen, which completely envelopes the body; they also wear silver bobs tied to their tresses.

DRY PILE, a voltaic arrangement originally intended to consist of solid elements. [GALVANISM.]

DRY ROT, a term very incorrectly given to a species of decomposition and destruction of the wood used in constructive operations, arising from the fermentation of the alburnum of the sap retained in the wood (under the influence of moist warmth and confined air); and the subsequent growth of a fungoid excrescence, which destroys the cohesion of the fibres of the wood to such an extent as to reduce it to a powder. It is from the latter phenomenon that the peculiar action known as the "dry rot" takes its name, though, unquestionably, the action itself is not properly speaking a *dry* one.

It is usually considered that wood felled at those periods of the year in which the sap is rising in the trees is more exposed to this species of decay than when it has been felled later in the season; but, in fact, it would appear that the really important condition to be attained in employing any description of wood is, that a free circulation of air should be maintained around it in every direction. There have been suggested a countless number of processes for the prevention of dry rot; amongst the most successful of which may be cited Kyan's process, or the use of a solution of the bichloride of mercury; Payne's process, or the use of the sulphate and muriate of lime and the sulphate of iron in solution; Margary's process, or the use of a solution of the sulphate of copper; Burnett's process, or the use of a solution of the chloride of zinc; Boucherie's process, or the use of the pyrolignite of iron; and Bethell's process, or the use of creosote, with a small proportion of the pyrolignite of iron. It seems, nevertheless, that the results of all these processes are at the best uncertain; and it therefore behoves the builder carefully to select the soundest timber for the bearings in walls, and such other positions wherein it may be exposed to damp; and, above all things, to leave as much space as possible around the bearings, and to secure a free circulation of air about them.

There are some valuable treatises by Faraday and by Birkbeck on the subject of the prevention of dry rot, based upon the principles mentioned here.

DRYING MACHINES. A valuable improvement has been made within the last few years in the mode of drying textile fabrics which have been bleached or otherwise wetted. In the ordinary mode of drying by exposure to the open air, the moisture gradually evaporates; in a hot room this evaporation is expedited; but in the drying machine the mechanical principle of centrifugal force is applied in a singular way.

A drying machine was brought into use in Paris in 1839, by Messrs. Penzolt and Levesque. It acted on the centrifugal system. It consisted of two drums or cylinders, one within the other; the inner one being pierced with holes. The textile goods, wetted by the process of washing, scouring, or bleaching, were placed within the inner cylinder, which was then made to revolve with a rapidity of 4000 turns in a minute; the cloth was driven forcibly against the perforated surface, and the water driven through the holes with such irresistible force that the cloth became nearly dry in three or four minutes.

In 1844 Messrs Keeley and Alliott, of Nottingham, patented a very elaborate machine to facilitate the scouring, bleaching, or dyeing of cloth. The same inventors had before introduced a machine very similar in principle to that of Messrs. Penzolt and Levesque; but in the new machine, the cloth is put into a certain compartment, the bleaching or scouring liquid into another compartment, and the machine is made to revolve rapidly; the centrifugal force generated by the movement drives the liquid speedily and effectually through every pore of the cloth—leaving the cloth instantly afterwards almost in a state of dryness, and bleached likewise.

This principle, the application of centrifugal force to produce a drying action, is now very extensively adopted; the methods vary considerably in detail, but their general arrangement may be understood from the above two examples.

DUAL NUMBER. The Greek, Sanscrit, and Gothic of ancient, and the Lithuanian of modern languages, in addition to the undefined plural which they share with other tongues, possess also forms of the verb and noun in which *two* persons or things are denoted, called the dual number. On a careful consideration of the suffixes which are supposed to convey this notion, there seems reason for believing that the idea of duality was not originally contained in them, but simply that of unlimited plurality.

The suffix of plurality which belongs to the Indo-Teutonic languages seems to have had two forms, *en* and *es*, as in the English *housen* and *houses*. Thus the Greeks had two forms for the first person plural of their verbs active, *tuptomen* and *tuptomes*. In the second person, the Latin language gives the suffix *tis*, *scribitis*; probably the Greek, in its oldest character, would have presented us with a suffix *tes*, but the forms of that language which have come down to us give only the abbreviated *te*, *tuptete*. But if there existed a double form for the second person as well as for the first, we should in that case have also *tupteten*, or rather *tupteton*, seeing that to the Greek ear *ton* was a more familiar termination. In the third person the dual *ton* might well represent a plural, as the oldest form of that person in the singular gives a suffix *ti, esti;* and this, with the plural termination *n*, would produce a syllable which might readily take the same shape as the second person dual.

In the nouns the same analogy prevails. The nominatives and genitives of the dual and plural differ no more than might be expected in two dialects: in the dative, the difference consists in the one number having a final *n*, the other an *s;* while the accusative dual has lost the final sigma, a fate common enough with that letter in the Greek language, as may be seen even in the plural nominatives, *mousai, logoi*, which the analogy of the other declensions proves to have once possessed that letter. We have already seen an example of the same loss in the second person plural of the verb. Similarly in the Lithuanian from *pona* "master," we have a pl. ac. *ponùs*, dual ac. *ponù;* pl. dat. *pónāms*, dual dat. *pónūm.* In the pronouns, again, the same confusion of the two numbers prevails. Thus the Greek dual of the pronoun *I* contains the very same element, *no*, which in the Latin is appropriated to the plural.

In the Gothic verb the same principle may be traced. A specimen may be seen in the second person dual which has the suffix, *ts*, a form more closely approaching the old plural suffix *tis*, which has been above mentioned, than even the *th*, which is the suffix of the same person in the plural.

Again in the Lithuanian, while the first person plural of the verb, which ends in *me*, has derived that suffix from the older form *mas*, or *mes*, the dual of the same person ends in *va*, which has a strong resemblance to our plural *we*, while the plural and dual of the second person have for suffixes respectively *te* and *ta*, both originating in an earlier *tas* or *tes*. The same observation applies to the Sanscrit verb of the Parasmaipadam form of the potential and imperative moods, and of the preterits called by Bopp "Præteritum augmentatum uniforme et multiforme." The terminations of the first persons of the dual and plural respectively in the present of the Parasmaipadam are *was* and *mas;* of the second and third persons dual respectively, *thas* and *tas;* and of the second person plural, *tha.*

If it be admitted then that the dual in its origin was not confined to the notion of two, it remains to consider how that notion was superadded. Perhaps the following may not be an unreasonable conjecture. In many countries there are two or more dialects co-existing, one among the educated and in towns, which we may call the language of books; the other, the older and more natural language of the district, not yet wholly supplanted by the former. In the places of public meeting, whether for religious or political purposes, the dialect which happens to belong to the more educated class will prevail, while the other, as genuine, though not so fortunate a dialect, will still maintain its ground by the fireside. The former will be addressed to hundreds, the latter commonly to one or two individuals. Hence the colloquial and familiar dialect of the cottage may well be borrowed by even the public speaker when speaking of two persons; and thus the notion of duality, which at first was only accidentally united with a certain suffix, becomes in the end the inseparable and essential meaning thereof. Something parallel to this may be seen in the double forms of the English verb *to be.* While *am, art, is*, are honoured by the favour of the learned, the unlearned still retain, and with as good a title, the genuine forms *be, best, bes*, or *be.* These are both indicatives, yet it is already a common practice to look upon the latter set of forms as constituting a subjunctive. Of course what has been here said does not apply to forms in which a visible representation of the idea "two" presents itself, as in the Lithuanian *tùdu*, "these two," from *ta*, "this," *anudu*, "those two," from *an*, "that."

An interesting discussion by William Humboldt on the dual is printed in the 'Transactions of the Academy of Sciences of Berlin,' for the year 1827 ('Abhandlungen der historich-philologischen Klasse der Königlichen Academie der Wissenschaften zu Berlin,' aus dem Jahr 1827, p. 161–107), to which we refer our readers, though the views explained in that essay differ from those of the present article.

DUCAT, DUCATOON. [MONEY.]

DUCTILITY is that property of bodies, and more especially of certain metals, in virtue of which they can be drawn out in length, while their diameter is diminished without any actual fracture or solution of continuity; in other words, it is upon this property that the wire-drawing of metals depends. The following is given in most chemical books as the order of ductility of the metals which possess the property in the highest degree; that of the first-mentioned being the greatest: *gold, silver, platinum, iron, copper, zinc, tin, lead, nickel, palladium, cadmium.* This list would appear to require revision, and it would be very desirable to be able so to represent the ductility of the various metals numerically. In the wire trade considerable confusion exists in the gauge, that used in Birmingham for iron wire differing from that used for gold, silver, &c., while both differ from the Lancashire gauge for round steel wire. What is wanted is a scientific inquiry for the purpose of determining the order and amount of ductility of the various metals. In our best books on chemistry the statements are loose, and unsatisfactory. Thus in Gmelius, 'Handbook of Chemistry,' (Cavendish Society's Translation), it is stated (vi. 204) that *gold* is the most ductile of the metals, because it can be hammered into leaves $\frac{1}{282,000}$th of an inch in thickness, thus confounding *malleability* and *ductility*, which are different properties. It is further stated, that one grain of gold may be made to cover 56·75 square inches; or be drawn into a wire 500 feet in length. In like manner it is stated that *silver* can be beaten out into leaves 0·00001 inch in thickness; while one grain of the metal can be drawn into a wire 400 feet in length. On referring however to *platinum*, the ductility is at once ascertained, because Dr. Wollaston has furnished accurate data on the subject. Platinum alone can be drawn into a wire $\frac{1}{1940}$th of an inch in thickness, but when protected by being enclosed in a silver wire, it may be gradually reduced to $\frac{1}{30,000}$th of an inch in thickness, but in such case the wire is not coherent in long pieces.* The circumstance that silver is soluble in nitric acid, and platinum not, allows this artifice to be practised, for after having drawn the compound wire to its extreme limit, the silver can be washed off in nitric acid, leaving its central core of platinum thus considerably reduced. In the above list, a low degree of ductility is given to *palladium*, which is clearly wrong, for the latest authorities state this metal to be somewhat less ductile than platinum. Both platinum and palladium can be rolled out into thin leaves or *foil*, but their malleability is very inferior to that of gold and silver, and even copper. *Copper* and *iron* are said to be capable of being drawn out into very thin wire; sheet iron has been produced the $\frac{1}{3500}$th of an inch in thickness. Between the temperatures of 100° and 150°, *zinc* may be extended into thin plates and wires, heat being required to get rid of the crystalline texture. *Tin* cannot be drawn into fine wires, but *nickel* may be hammered either cold or hot into plates $\frac{1}{100}$th of an inch in thickness, and drawn out into wires $\frac{1}{50}$th of an inch in diameter. It is probable also, that *cadmium* is wrongly placed, since it can be easily beaten out into thin plates, or drawn into wires, whereas *tin* cannot be drawn into a fine wire. Hence it appears that although the malleability and ductility of metals are connected, they are not always in the same proportion; iron, for example, though very ductile, cannot be beaten into very thin laminæ. The difference between ductility and malleability has been ascribed to the figure and arrangement of the particles of the metals; the malleable metals may be conceived to consist of small plates, and the ductile metals of minute fibres placed beside or over each other; the one slide by their flat surfaces, the other lengthen and exert an adhesion from one extremity to the other. [WIRE-DRAWING.]

Ductility is not confined to the metals. *Glass* at a red heat possesses the property in a remarkable degree. If a rod of glass be heated at the enameller's lamp, and a portion of it drawn out and attached to a wheel, which is then to be turned rapidly, it will be encircled by a number of coils of very fine glass thread with an elliptical section, one diameter being three or four times larger than the other. The flexibility of these fibres is almost equal to those of the *spider's web*, which is also a good instance of ductility. Certain *clays* mixed with water also form a ductile mass. Hand-spun *yarns* often present threads surprisingly fine and perfect, some flax-yarns in the Great Exhibition of 1851 being what are technically known as 1200's *warp*, and 1600's *weft.*

DUELLING. The rise of the practice of duelling is to be referred to the trial by battle which obtained in early ages, jointly with the single combat or tournament of the age of chivalry, which again most probably owed its own existence to the early trial by battle. The trial by battle, or duel (as it was also called), was resorted to, in accordance with the superstitious notions of the time, as a sure means of determining the guilt or innocence of a person charged with a crime, or of adjudicating a disputed right. It was thought that God took care to see that, in every case, innocence was vindicated and justice observed. The trial by battle was introduced into England by William the Conqueror, and established in three cases; namely, in the court-martial or court of chivalry, in appeals of felony, and in civil cases upon issue joined in a writ of right. Once established as a mode of trial, the duel was retained after the superstition which had given rise to it had died away, and was resorted to for the purpose of wreaking vengeance, or gaining reputation by the display of courage. Then came the age of chivalry, with its worship of punctilio and personal prowess, its tilts and tournaments, and the duel, originally a mode of trial established by law, became in time (what it now is) a practice dependent on fashion or certain conventional rules of honour.

It is an instance of the length of time for which abused and improper obsolete laws are often allowed to encumber the English statute-book, that the trial by battle in appeals of felony and writs of right was only abolished in 1818. An appeal of felony had been brought in the previous year, in a case of murder, and the appellee had resorted to his right of demanding wager of battle (Ashford *v.* Thornton, 1 Barn. and Ald. 405). The appeal was not proceeded with, so that the barbarous encounter did not take place. [APPEAL.]

---

* In Moseley's 'Illustrations of Mechanics' (1839), the finest platinum wire is said to be $\frac{1}{3,000,000}$th of an inch in diameter, which is evidently a clerical blunder, or a printer's mistake, in putting two ciphers too many. Yet we find this mistake repeated in Dr. Golding Bird's 'Natural Philosophy' (1854), and, as if to remove all doubt in the matter, the fraction, which we have no means of measuring, is printed in words instead of figures. "The finest of these wires is but one three-millionth of an inch in diameter, and 140 of them placed together would just equal in thickness a single fibre of silk." It is remarkable that this statement is given on the high authority of Dr. Wollaston, when it will be seen, on referring to his paper contained in the 'Phil. Trans.' (1813, p. 114), that his finest platinum wire did not exceed $\frac{1}{30,000}$th of an inch in diameter.

The law of England makes no distinction between the killing of a man in a duel and other species of murder: and the seconds of both parties are also guilty of murder. But the practice of duelling has been maintained against laws human and divine; and it may be well to enter a little into the reasons of this practice, without reference to its illegality, or to its variance, which no one will dispute, with Christianity.

The professed object of a duel is *satisfaction.* The affronter professes to have satisfied the man whom he has affronted, and the challenger professes to have been satisfied by the man whom he has challenged, after they have fired, or have had an opportunity of firing, pistols at one another. That this satisfaction is of the nature of *reparation*, is of course out of the question. Satisfaction in this its most obvious sense, or reparation for an injury, cannot be effected by the injured man firing at his injurer, and being fired at in return.

The satisfaction furnished by a duel is of a different sort, and of a sort which, were it distinctly comprehended, would at once show the absurdity of the practice; it is a satisfaction occasioned by the knowledge that, by standing fire, the challenger has shown his courage, and that the world cannot call him coward. Now it is clear that there would be no reason for dissatisfaction on this point, previous to the fighting of the duel, and therefore no reason for seeking satisfaction of this sort, were it not that the practice of duelling existed. Were men not in the habit of fighting duels, and therefore not expected to expose themselves to fire after having received an affront, there would be no ground for calling their courage into question, and therefore no necessity for satisfying themselves that the world thinks them courageous. The practice of duelling thus causes the evil which it is called in to remedy,—the injury for which it is required to administer satisfaction. And every one who saw this would immediately see the absurdity of the practice. But the word *satisfaction* is conveniently ambiguous. When one speaks of it, or hears it spoken of, one thinks of that satisfaction which means reparation for an injury, and which is not the satisfaction furnished by the duel. Thus are men the dupes of words.

The real object then of the duel is, in most cases, to satisfy the person who provokes it, or who sends the challenge, that the world does not suspect him of a want of courage; and it will be useful to observe, in passing, that the duel furnishes this sort of satisfaction as well to the man who gave the affront, as to him who was affronted. Its object also, in certain cases, is doubtless to gratify the vengeance of the man who has received an affront. But in all cases the object which is professed, or generally understood to be professed, of satisfaction in the sense of reparation for the affront, is no more than a pretence.

But though the practice of duelling cannot effect the good of repairing an injury, it may very possibly effect other sorts of good. The advantage of the practice of duelling is generally said to consist in its tendency to increase courtesy and refinement of manners; as it will be a reason for a man to abstain from giving an affront, that he will be subjected in consequence to the fire of a pistol.

Now it is clear in the first place, that all the affronts which are constituted reasons or grounds of duels by fashion, or the law of honour or public opinion, are so constituted because they are judged by public opinion deserving of disapprobation. If then the practice of duelling did not exist, public opinion, which now constitutes these affronts grounds of a duel, as being deserving of disapprobation, would still condemn them, and, condemning them, provide men with a reason to abstain from them. Thus there would still exist a reason to abstain, in all cases in which the practice of duelling now provides a reason. But, in the second place, the practice of duelling itself depends on public opinion alone. A man fights because public opinion judges that he who in certain cases refuses to challenge or to accept a challenge is deserving of disapprobation: he fights from fear of public opinion. If he abstain from giving an affront on account of the existence of the practice of duelling, it is because the fear of public opinion would oblige him to fight; he abstains then from fear of public opinion. Now we have seen that there would be the fear of public opinion to deter him from the affronts which now lead to duels, if the practice of duelling did not exist. Thus the practice of duelling does not in any case provide a reason to abstain, which public opinion would not provide without its aid. As a means then of increasing courtesy and refinement of manners, the practice of duelling is unnecessary; and inasmuch as its tendency to polish manners is the only advantage which can, with any show of probability, be ascribed to it, there will be no good effects whatever to set against the evil effects which we now proceed to enumerate. There will be no difficulty in striking the balance between good and evil.

First, the practice of duelling is disadvantageous, inasmuch as it often diminishes the motives to abstain from an affront. We have seen that the existence of this practice leads public opinion to enjoy itself concerning the courage of the two persons, who (the one having affronted and the other having been affronted) are in a situation in which, according to custom or fashion, a duel takes place. Public opinion then is diverted by the practice of duelling from the affront to the extraneous consideration of the courage of the two parties. It censures the man who has given the affront only if he shrinks from a duel; and even goes so far as to censure the man who has received the affront for the same reason. Thus in a case where a man, reckless of exposing his life, is disposed to give affronts, he is certain that he can avert censure for an affront by being ready to fight a duel; and in a case where a bold or reckless man is disposed to affront one who is timid, or a man expert with the pistol one who is a bad shot, he can reckon on the man whom he affronts refusing to fight, and on censure being thus diverted from himself who has given an affront to him who has shown want of courage.

Secondly, the practice of duelling is disadvantageous, as increasing the amount of injury which one man can do to another by an affront.

Thirdly, the practice of duelling affords means for the gratification of vengeance; and thus tends to hurt the characters of individuals, by the encouragement both of that feeling, and of hypocrisy in those who, thirsting for vengeance, and daring not to own it, profess (in the common ambiguous phrase) to be seeking for satisfaction.

Fourthly (which is the most important consideration), there are the evils entailed by the deaths which the practice of duelling brings about—evils entailed both on the persons dying, and on their surviving relatives and friends. It is an evil that a man should be cut off from life "unhouseled, unappointed, unaneled." It is an evil that he should be taken from relatives and friends to whom his life is, in different ways and degrees, a source of happiness; from parents who have centred in him their hopes, and to whom, in their declining years, he might be a comfort, or from a wife and children who look to him for support.

Such are the evil effects of the practice of duelling; and there being no list of good effects to set against them, it follows immediately that the tendency of the practice is, on the whole, evil. There arises, then, the question, how is it to be got rid of?

Were a man who had killed his antagonist in a duel compelled by the law to support, or assist in supporting, some of his surviving relatives, this, so far as it would go, would be a punishment popular and efficacious. Public opinion would then infallibly be against the man who, having incurred the penalty, should endeavour to avoid it. And such a punishment as this would furthermore be superior to the punishment of death, as being susceptible of graduation—as furnishing reparation to a portion of those who have been most injured, and as preserving the offender, that he may have all those opportunities, which his natural life will afford him, of improving himself and of benefiting others.

A mild and judicious legislation would tend to guide and improve public opinion; whereas such a legislation as the present tends only to confirm it in its evil ways.

And as legislation may and should assist the formation of a right public opinion, so is it possible and desirable to operate independently on public opinion, either that the absence of good legislation may, as far as is possible, be compensated for, or that good legislation may be assisted. This operation on public opinion must be brought about by the endeavours of individuals. It is the duty of each man to oppose this practice to the utmost extent of his power, both by precept and example,—to abstain from challenging when he has received an affront, and to refuse a challenge when he is considered to have given one, making public in both cases, so far as his situation allows, his reasons for the course which he takes, and thus producing an impression against the practice as widely as he can. In the second of these two cases, he must either be able to defend, or he must apologise for, that which was considered an affront. If he can defend it, or show that the evil to the person insulted was overbalanced by the good accruing to others, he refuses rightly to be fired at for having been the author of a benefit; or, if unable to defend the affront, he apologises for it, he performs a manly and a rational part in refusing to fire at a man whose feelings he has wantonly injured.

This duty is peculiarly incumbent on public men, whose sphere of influence is larger, and whose means of producing good effects by example are therefore greater, than those of others. A public man who should at all times refuse to challenge or to accept a challenge, resting his refusal on the ground of the evil tendency of duelling, not of the infraction of some other duty which an accident has in his case connected with it (as the violation of an oath), and who should at the same time preserve himself from suspicion or reproach by circumspection in speech, by a manly defence, where it is possible, and, where it is not, by a manly apology, would be a mighty aid for the extirpation of this practice.

The following three new articles of war were issued in the course of the year 1844, with a view to the abatement of duelling in the army:—

1. Every officer who shall give or send a challenge, or who shall accept any challenge to fight a duel with another officer, or who, being privy to an intention to fight a duel, shall not take active measures to prevent such duel, or who shall upbraid another for refusing or for not giving a challenge, or who shall reject or advise the rejection, of a

reasonable proposition made for the honourable adjustment of a difference, shall be liable, if convicted before a general court-martial, to be cashiered, or suffer such other punishment as the court may award.

2. In the event of an officer being brought to a court-martial for having acted as a second in a duel, if it shall appear that such officer had strenuously exerted himself to effect an adjustment of the difference on terms consistent with the honour of both parties, and shall have failed through the unwillingness of the adverse parties to accept terms of honourable accommodation, then our will and pleasure is, that such officer shall suffer such punishment as the court may award.

3. We hereby declare our approbation of the conduct of all those who, having had the misfortune of giving offence to, or injured or insulted others, shall frankly explain, apologise, or offer redress for the same; or who, having had the misfortune of receiving offence, injury, or insult from another, shall cordially accept frank explanations, apology, or redress for the same; or who, if such explanations, apology, or redress are refused to be made or accepted, shall submit the matter to be dealt with by the commanding officer of the regiment or detachment, fort, or garrison; and we accordingly acquit of disgrace, or opinion of disadvantage, all officers and soldiers who, being willing to make or accept such redress, refuse to accept challenges, as they will only have acted as is suitable to the character of honourable men, and have done their duty as good soldiers, who subject themselves to discipline.

DUET (*Duetto*, Ital. from *Duo*), a musical composition for either two voices or two instruments. According to the Padre Martini, the *duo* is a vocal composition in the severe ecclesiastical style, without any kind of accompaniment; the *duetto*, or diminutive of *duo*, one written more freely, in a lighter manner, and admitting accompaniment. The older word is now, however, become obsolete.

DUKE, the title given to those who are in the highest rank of nobility in England. The order is not older in England than the reign of King Edward III. Previously to that reign those whom we now call the nobility consisted of the barons, a few of whom were earls. Neither baron nor earl was in those days, as now, merely a title of honour; the barons were the great tenants in chief, and the earls important officers. It does not appear that in England there was ever any office or particular trust united with the other titles of nobility, viscount, marquis, and duke. They seem to have been from the beginning merely honorary distinctions. They were introduced into England in imitation of our neighbours on the Continent. Abroad, however, the titles of duke and marquis had been used to designate persons who had political power, and even independent sovereignty. The czar was Duke of Russia or Muscovy. There were the Dukes of Saxony, Burgundy, and Aquitaine: persons with whom the earls of this country would have ranked, had they been able to maintain as much independence of the king as did the dukes on the Continent of the Germanic or Gallic confederacy.

The English word duke is from the French duc, which originally was used to signify "a man of the sword (a soldier) and of merit who led troops." The remote origin is the Latin dux, a "guide," or a "military commander." The word is used by the Latin writers to signify generally any one who has military command, but sometimes "dux," as an inferior officer, is contrasted with "imperator," commander in chief. Under the Lower Empire, dux was the title of a provincial general, who had a command in the provinces. In the time of Constantine there were thirty-five of these military commanders stationed in different parts of the empire, who were all duces or dukes, because they had military command. Ten of these dukes were also honoured with the title of comtes [COUNT], or counts. (Gibbon, 'Decline and Fall,' &c., cap. 17.)

The German word *herzog*, which corresponds to our duke, signifies "a leader of an army."

The first person created a duke in England was Edward, Prince of Wales, commonly called the Black Prince. He was created Duke of Cornwall in parliament, in 1335, the eleventh year of King Edward III. In 1350, Henry, the king's cousin, was created Duke of Lancaster, and when he died, in 1361, his daughter and heir having married John of Gaunt, the king's son, he was created Duke of Lancaster, his elder brother Lionel being made at the same time Duke of Clarence. The two younger sons of King Edward III. were not admitted to this high dignity in the reign of their father: but in the reign of Richard II., their nephew Edmund was made Duke of York, and Thomas, Duke of Gloucester.

The dignity was thus at the beginning kept within the circle of those who were by blood very nearly allied to the king, and we know not whether the creation of the great favourite of King Richard II., Robert Vere, Earl of Oxford, Duke of Ireland, and Marquis of Dublin, is to be regarded as an exception. Whether, properly speaking, an English dignity or an Irish, it had but a short endurance, the earl being so created in 1385, and attainted in 1388.

The persons who were next admitted to this high dignity were of the families of Holland and Mowbray. The former of these was half-brother to King Richard II.; and the latter was the heir of Margaret, the daughter and heir of Thomas de Brotherton, a younger son of King Edward I., which Margaret was created Duchess of Norfolk in 1358. This was the beginning of the dignity of Duke of Norfolk, which still exists, though there have been several forfeitures and temporary extinctions. Next to them, not to mention sons or brothers of the reigning king, the title was conferred on one of the Beauforts, an illegitimate son of John of Gaunt, who was created by King Henry V., Duke of Exeter. John Beaufort, another of this family, was made Duke of Somerset by King Henry VI.

In the reign of Henry VI. the title was granted more widely. There were at one time ten duchesses in his court. The families to whom the dignity was granted in this reign were the Staffords, Beauchamps, and De la Poles. In 1470, under the reign of Edward IV., George Nevil was made Duke of Bedford, but he was soon deprived of the title, and Jasper Tudor was made Duke of Bedford by his nephew King Henry VII. in the year of his accession.

King Henry VIII. created only two dukes, and both were persons nearly connected with himself; one was his own illegitimate son, whom he made Duke of Richmond, and the other was Charles Brandon, who had married the French queen, his sister, and who was made by him Duke of Suffolk. King Edward VI. created three dukes; his uncle, Edward Seymour, the Protector, Duke of Somerset (from whom the present Duke of Somerset derives his descent, and, by reversal of an attainder, his dignity), Henry Grey, Duke of Suffolk, and John Dudley, Duke of Northumberland.

Queen Elizabeth found on her accession only one duke, Thomas Howard, Duke of Norfolk, attainder or failure of male issue having extinguished the others. He was an ambitious nobleman, and aspiring to marry the Queen of Scotland, Elizabeth became jealous of him: he was convicted of treason, beheaded, and his dignity extinguished in 1572; and from that time there was no duke in the English peerage except the sons of King James I., till 1623, when Ludovick Stuart, the king's near relative, was made Duke of Richmond, which honour soon expired. In 1627, George Villiers was created Duke of Buckingham, and he and his son were the only dukes in England till the civil wars, when another of the Stuarts was made Duke of Richmond, and the king's nephew, best known by the name of Prince Rupert, Duke of Cumberland.

In the first year after the return of Charles II. from exile, he restored the Seymours to their rank of Dukes of Somerset, and created Monk, the great instrument of his return, Duke of Albemarle. In 1663, he began to introduce his illegitimate issue into the peerage under the title of duke, his son James being made in that year Duke of Monmouth. In 1664, he restored to the Howards the title of Duke of Norfolk; and in 1665 he created a Cavendish, who had held a high military command in the civil war, Duke of Newcastle. In 1682, he created the Marquis of Worcester Duke of Beaufort. As for the rest the dignity was granted only to issue of the king or to their mothers. The only duke created by King James II. was the Duke of Berwick, his natural son.

Of the families now existing, beside those who are descended from King Charles II., only the Howards, the Seymours, and the Somersets date their dukedoms from before the Revolution. The existing dukedoms originally given by Charles II. to his sons are Grafton, Richmond, and St. Albans. To the Duke of Richmond Charles granted letters patent which entitled him to a tonnage duty on coal. In 1799 this duty was commuted for an annuity of 19,000*l.* a year. The Duke of Grafton is still paid a pension of 5843*l.* a-year out of the Excise revenue, and 3407*l.* out of the Post-office revenue. The Duke of St. Albans is Hereditary Grand Falconer of England. Under King William and Queen Anne several families which had previously enjoyed the title of earls were advanced to dukedoms, as Paulet Duke of Bolton, Talbot Duke of Shrewsbury, Osborne Duke of Leeds, Russell Duke of Bedford, Cavendish Duke of Devonshire, Holles Duke of Newcastle, Churchill Duke of Marlborough, Sheffield Duke of Buckinghamshire, Manners Duke of Rutland, Montagu Duke of Montagu, Douglas Duke of Dover, Gray Duke of Kent, Hamilton Duke of Brandon; besides members of the royal family and Marshal Schomberg, who was made an English peer as Duke of Schomberg. This great accession gave an entirely new character to the dignity. King George I., besides the dukedoms in his own family, made Bertie Duke of Ancaster, Pierrepoint Duke of Kingston, Pelham Duke of Newcastle, Bentinck Duke of Portland, Wharton Duke of Wharton, Brydges Duke of Chandos, Campbell Duke of Greenwich, Montagu Duke of Manchester, Sackville Duke of Dorset, and Egerton Duke of Bridgewater. George II. created no duke out of his own family, and the only addition he can be said to have made to this branch of the peerage, was by enlarging the limitation of the Pelham dukedom of Newcastle so as to comprehend the Clintons, by whom the dukedom is now possessed. From 1720 to 1766, there was no creation of an English duke except in the royal house. In that year the representative of the ancient house of Percy was made Duke of Northumberland, and the title of Duke of Montagu, which had become extinct, was revived in the Brudenels, the heirs. The same forbearance to confer this dignity existed during the remainder of the reign; and during the reign of George IV. no dukedom was created out of the royal house, till the eminent services of the Duke of Wellington marked him out as deserving the honour of the highest rank which the king has it in his power to confer. His dukedom was created in 1814, forty-seven years after the creation of a Duke of Northumberland. The Marquis of Buckingham was advanced to the rank of Duke of Buckingham and Chandos in 1822, so that for a hundred years, namely, from 1720 to 1822, only four families were admitted to this honour.

During the reign of William IV. two dukedoms were created, Gower Duke of Sutherland, and Vane Duke of Cleveland.

The whole number of dukes in the English peerage is at present twenty, exclusive of the blood royal. There are seven Scottish dukes (Argyll, Atholl, Buccleuch, Hamilton, Lennox, Montrose, and Roxburghe), of whom one (Hamilton) is also an English duke. The only Irish duke is the Duke of Leinster.

All the dukes of England have been created by letters patent, in which the course of succession has been plainly pointed out. Generally the limitation is to the male heirs of the body.

DULCIMER, a very ancient musical instrument, and not yet entirely fallen into disuse. There seems to be little doubt of this being the psaltery, or psalterium, or nebel, of the Hebrews. In shape it was sometimes a triangle, sometimes a trapezium, as appears from Luscinius, Kircher, and Blanchinus, a fact overlooked by Sir John Hawkins, who argues in opposition to Kircher, that the instrument took different names according to its different forms. The dulcimer, as now used by street-musicians, to whom it is confined, is a trapezium in shape, has many strings, two to each note, and is struck by a pair of sticks with wooden or metallic knobs. The tone much resembles that of the old spinnet, and in skilful hands the instrument is of rather an agreeable kind. [CITOLE.]

DULCIN. [MANNITE.]

DULCOSE. [MANNITE.]

DUMASIN. A derivative chemical compound from acetone. Nothing satisfactory is known respecting it.

DUMBNESS. [DEAF AND DUMB.]

DUNES, DOWNS, and also **DENES,** are hillocks of sand formed along the sea-coast.

The word thus variously given has been usually regarded to be formed from the French *dune*, or from the Celtic *dun*, a mountain. A monastic history, repeatedly cited with respect to it, is again cited here; because it preserves two forms of this word as applied to the subjects of this article. This is the 'Compend. Chronolog. Exord. et Progress. Abbat. Clariss. B. Mariæ de *Dunis*,' by Charles de Visch, in which it is said, "Vallem reperit arenarum collibus, quos incolæ *Duynen* vocant undique cinctam."

The late learned printer, Mr. Richard Taylor, F.S.A., the editor of Tooke's 'Diversions of Purley,' in an etymological note appended to a paper by his cousin, Mr. R. Cowling Taylor, F.G.S., referred to below, says, "The appellation Denes for the sandy alluvial tracts next the sea on the Norfolk coast corresponds with *Dunes*, *Duynen*, used by the French and Flemish for those on the opposite coast. Thus Duynkerke (Dunkirk) derives its name from the church originally founded on the Denes, on the first establishment of that town."

The term *Downs* is also given, in England, to a hilly tract, or a large open plain on elevated land, whether maritime or inland, as the South Downs of the chalk of Sussex, the North Downs of that of Kent, Epsom Downs in the county of Surrey, St. Austell Downs in that of Cornwall, &c.

The mode of the formation of sand-dunes is this: the waves of the sea, in certain localities, drive upon the beach a certain quantity of fine sand, which, becoming dry during low water, is carried up still higher by the wind till, meeting with the obstruction of large stones, bushes, tufts of grass, &c., it is accumulated into little heaps; these, offering still greater surface of resistance as the sand increases upon and against them, soon rise into mounds of considerable height, whose number, arrangement, and dimensions depend naturally upon the size and distribution of the obstacles to which they owe their existence. If these obstacles are close-set, there will be little more than one range of sand hillocks, and, if very close, these will in time unite so as to form a continuous ridge. Should the arresting objects, on the contrary, be thinly scattered, and at different distances from the brink on a shelving coast, there will be several ridges of hillocks, the one behind the other. Examples of all these forms will be noticed in the sequel. The dunes having attained a certain height, the wind has no longer the power to increase their elevation, and they are then urged forward upon the land. The way in which this is effected is easily conceived. On the windward side of the hillocks the grains of sand are forced up to the top, whence they are swept off as they arrive, and fall by their own weight on the opposite slope. Thus the mass goes on invading the land, while fresh material is constantly brought by the sea.

This progress inland depends, however, upon the habitual direction of the wind and the relative direction of the coast-line. In Gascony the sand advances eastward, and generally along the whole coast of France, from Bayonne to Calais, the dunes progress in a north-easterly direction, the wind blowing most frequently from the south-west; whereas from Calais to Dunkirk, the coast trending in the direction of the wind, they make no progress inland, but form a ridge or chain parallel with the coast. The rapidity with which the sands advance is, in some cases, most alarming. Between the mouths of the Adour and the Garonne their progress is about sixty feet yearly; nor is it easy to arrest their march. The town of Mimizan is in part buried under the sands, against whose encroachment it has been struggling for the last five-and-twenty years. In Brittany, also, a village near St. Pol de Leon has been entirely covered with the sand, so as to leave no part visible but the steeple of the church.

In the Boulonnais the advance of the dunes has been almost wholly arrested since the works there executed by Cassini. The inhabitants plant a species of Cyperaceæ (the *Carex arenaria*), termed by them *oya*, which thrives well, and fixes the sands. This process is so much the more advantageous, as every hillock which becomes fixed is an effectual barrier against the invasion of fresh sand from the sea. In Gascony the peasants force the wind, in some measure, to drive back what it brought. Thus, when the wind blows in a direction contrary to that which pushes the downs upon the land, they toss the sand high into the air with shovels, and in this manner get rid of a portion of it: this portion, however is very small, and the prevailing winds being from the south-west the sands continue to advance in spite of all their efforts.

Dunes sometimes intercept the flow of water to the sea, forming stagnant pools between and behind them, which give rise to an aquatic vegetation and the occasional formation of a kind of peat.

Dunes also skirt the shores of Spain, Holland, England and Wales, and other countries, their formation being, in fact, a process which must take place to a greater or less extent on most low sandy coasts. In England, the north coast of the county of Norfolk, "between Hunstanton and Weybourne," says Sir C. Lyell ('Principles of Geology,' 9th ed. chap. xix. p. 305–307), "low hills or dunes of blown sand are formed along the shore, from 50 to 60 feet high. They are composed of dry sand, bound in a compact mass by the long creeping roots of the plant called *Marram* (*Arundo arenaria*)." He inserts a view (probably derived from the 'Geology of East Norfolk,' by the late Mr. Richard Cowling Taylor, F.G.S., which he cites) of the church of the ancient village of Eccles, half buried in the dunes, the inland slope of which is represented. At this spot they also occupy the site of houses which were still extant in the year 1605. Between it and Winterton, to the south-east, they have barred up and excluded the tide for many hundred years from the mouths of several small estuaries. Similar hills of blown sand, affording temporary protection to the coast, extend from near Happisburgh, north of Eccles, to the port of Yarmouth on the south. Mr. Taylor has also noticed the ridges of sand, another form of these accumulations, passing into dunes, provincially termed "meals" (probably from the same source with the Anglo-Saxon *mæl*, a boundary) and "meal-hills," by which the harbours of Cley, Blakeney, Wells, Burnham, and Brancaster, all on the north coast of the county, are securely defended from the fury of the northerly gales. ('Phil. Mag.,' 2nd series, vol. i. p. 427.)

As already indicated, the dunes of our eastern shores depend essentially for their formation, and also for their degree of permanence, on the remarkable disposition of the plants called *Marram*, and of the *Arundo arenaria*, or sea-reed, "in particular, to collect around them, to hold in a net-work composed of their fibres, stems, and branches, the loose and shifting sands; to bind in one comparatively compact mass, a substance which is apparently little adapted to the important office it is designed to fulfil." Other grasses and plants, however, uniting with the sea-reed to produce this effect, are on the Norfolk coast confounded with it, in popular language, under the appellation of *Marram* (probably from the Gælic *muran*, sea-reed, or perhaps from the Dutch *marren*, to bind), which is given to all of them collectively, or indifferently to any; a confusion which scientific writers on this subject have not always avoided. Among these plants the *Elymus arenarius*, or upright Sea-Lyme grass, the *Carex arenaria*, or Sea-Carex, and the *Festuca rubra*, or Creeping Fescue grass, are the most important and effective. As in France, so in Holland, and on our own eastern coast, the *Arundo arenaria* and *Carex arenaria* have been cultivated with some care on account of their utility in consolidating the sands. Acts of parliament have been passed for the preservation of *Marram*. In continuation of the view of the subject just quoted, Mr. R. C. Taylor (in 'Phil. Mag.,' as already cited, p. 296–297), has described, substantially as follows, the agency of the *A. arenaria* in this part of the process of formation of sand-hills, as examined by himself, in Norfolk, Suffolk, and Hampshire:—A small portion of the sea-reed fixes itself upon a bed of "shingle" or pebbles, with perhaps scarcely sand sufficient to cover the first root. Rapidly it sends round its creeping stolones, and these serve to arrest some portion of the sands that are constantly moved by the winds. Occasionally the quantity is sufficient for a time to overwhelm the young plant; soon it rises with increased vigour to the surface; now appearing not as one, but as many plants. Mr. Taylor once observed a single plant which had struck out stolones, ten and twelve yards in length, radiating from the original stem, their extremities thus forming a circle upwards of twenty yards in diameter. [Over and beneath which space the sand-compacting structure was thus extended.] The joints of the shoots were from six to nine inches asunder, and from each or most of these a root was directed downwards into the sand, and one or two young shoots upwards. Calculating by the number of stolones, it thus appears that this plant, during a single year, had multiplied itself five hundred-fold, independent of the further power of production by seed. Again, the sand accumulates; layer after layer succeeds; the *arenaria* spreads its shoots still further and higher, and always sends forth its creepers in search of the newly-collected sand [by the nutritive emanations of which, doubtless the vital forces of the plant on the side towards that sand are stimulated]. By its continued agency a small hillock is formed, which, by the gradual extension of the same vegetative and accumulative processes, becomes in time a ridge many feet in elevation—a "meal;" or a sand-cliff, or "dune," on which the most boisterous wave is rarely capable of encroaching. But there are limits to this resistance of the waves, which, with some related phenomena of coast-action, we must proceed to consider.

Professor Phillips, in his 'Memoirs' of his uncle, Dr. William Smith [PHILLIPS, JOHN, and SMITH, WILLIAM, in BIOG. DIV.], has sketched in the following comprehensive manner, the philosophy of the Norfolk sand-dunes, and their relation to the changes of the coast-line.

"Along all this coast (from near Happisburgh to Winterton) the sea might enter, and spread in broad and winding sheets over 40,000 acres of land, but for a natural barrier of sand-hills, thrown up into a narrow irregular ridge by the action of the sea and the wind, and fixed by the growth of the 'marram,' or *Arundo arenaria*. The set of tide along this coast is from the N.W., and this being the line of the mud-cliffs and sand-hills, the whole of the sea-barrier thus described is raked by the currents, and the materials of which it is composed are perpetually drifted to the S.E., to augment the mass of sand-banks about Yarmouth Haven. The wasting of the cliffs to the north supplies the materials for the aggregation and renewal of the sand-hills, or dunes, and the whole coast is in motion; so long, however, as the sand-hills maintain a continuous unbroken line, they offer an effectual though variable barrier to the sea; what they have of this continuity and integrity is owing to the growth of the valuable plant already named, for its roots spread amongst and bind together the sand, and its 'bents' (stalks) check the devastating action of the wind. Placed thus in unstable equilibrium, the state of the sand-hills at any moment expresses the balance of the integral effects of the sea-wind and vegetation, and from time to time this balance is unfavourable to the safety of the inland country; for the wind often conquers the marram, by heaping up sand more abundantly where this plant grows the best; inequalities are thus occasioned; tempests succeed; the relatively depressed parts of the sandy chain yield to the wind, receive the spray, and admit unusually elevated waves of the sea. 'Gaps' or 'breaches' (fearful name!) are thus generated; the ocean, swelled by north-west winds, rushes in; the internal rivers are choked by the simultaneous flooding of the Yare with salt water; the marshes are drowned, and years pass before the soil recovers its natural state."

The manner in which Dr. Smith succeeded in conquering this fearful state of things,—as it existed in 1801, when the breaches in the line of sand-hills amounted altogether to one mile in length,—by imitating the natural embankments thrown up by the sea on the same shore, though most important as an operation of engineering, is foreign to our present subject, regarded as one of science. It is described in the Memoirs just cited, pp. 50–54.

Of the two alternating processes described by Professor Phillips, Sir C. Lyell, from his own observations and those of Mr. R. C. Taylor, has related some facts which are particular instances; of which those consisting in the restraint by the sand-dunes of the incursions of the ocean, have been already stated above; while the following show some additional consequences of the submersion of the barrier they form, and also in what manner the production of dunes is carried on in some localities of the same coast, simultaneously with the encroachment of the sea upon the land, of which other examples will be given.

The ancient villages of Shipden, Wimpwell, and Eccles (already mentioned) have disappeared; several manors and large portions of neighbouring parishes having, piece after piece, been swallowed up; nor has there been any intermission, from time immemorial, in the ravages of the sea along a line of coast twenty miles in length, in which these places stood. When Sir C. Lyell visited Eccles in 1839, the sea was fast encroaching on the sand-hills, and had laid open on the beach the foundations of a house, the upper part of which had evidently been pulled down before it had been buried under the sand. There are records of nine breaches, from 20 to 120 yards wide, having been made through the dunes between Eccles and Winterton noticed above, by which immense damage was done to the low grounds in the interior. An inland cliff, about a mile long, at Winterton, shows clearly that at that point the sea must have penetrated formerly farther than at present. But when the sufficiency of the meals and dunes securely to protect the harbours of Cley and Wells, and others, is affirmed to be dependent on "the present set of the tides,"—and is cited as "affording a clear proof that it is not the strength of the material at particular points that determines whether the sea shall be progressive or stationary, but the general contour of the coast,"—we conceive that the resisting agency of the objects and process forming the particular subjects of this article, is greatly underrated; while we are precluded from admitting the conclusion to be altogether true, even with respect to secular periods, by the fact of that secular change in the contour of coast-lines which is constantly in progress, and which Sir C. Lyell has himself evinced to play so important a part in historical physical geography.

Mr. R. C. Taylor has also described the dunes of South Wales, and some attendant phenomena ('Phil. Mag.,' 2nd series, vol. i. p. 427). The tides on this coast attain a great elevation. The marshes of Pembrey in Caermarthenshire have four or five concentric ridges of sand-hills, forming as perfect and permanent barriers against the sea as the art of man could execute. The mouth of the river Ogmore, in Glamorganshire, presented in 1827 a singular appearance of desolation, through the agency of the wind and sand. Its ancient channel was filled up for two miles, houses were rendered uninhabitable, and sand-hills were raised to the height of nearly 150 feet. "The mountains which bound the harbour," Mr. Taylor observed at that time, "will check the advance of this sand-flood into the interior, otherwise it threatens to overwhelm all the lands which adjoin it; while the squalls of wind, rushing down the steep valleys, occasion eddies, which deposit the sand at an elevation apparently far beyond the reach of such an irresistible enemy."

Much information respecting the sand-dunes of Cornwall, their encroachment on the land, and its counteraction by the use of the *Arundo arenaria*, will be found in the 'Parochial History' of that county by the late Mr. Davies Gilbert, P.R.S., and in the late Messrs. Lysons's 'Magna Britannia.'

"M. Elie de Beaumont [in his 'Géologie Pratique,' p. 218] has suggested that sand-dunes in Holland and other countries may serve as natural chronometers, by which the date of the existing continents may be ascertained. The sands, he says, are continually blown inland by the force of the winds, and by observing the rate of their march we may calculate the period when the movement commenced." On this, Sir C. Lyell, whose 'Principles' we are again citing, observes "But the example just given [that of Eccles] will satisfy every geologist that we cannot ascertain the starting point of dunes, all coasts being liable to waste, and the shores of the Low Countries in particular being not only exposed to inroads of the sea, but, as M. de Beaumont himself has well shown, having, even in historical times undergone a change of level. The dunes may indeed, in some cases, be made use of as chronometers, to enable us to assign a minimum of antiquity to existing coast-lines; but this test must be applied with great caution, so variable is the rate at which sands may advance into the interior."

Dr. Boué has pointed to sandy sea-beaches as being the only formations now in progress, which are similar to deserts. [DESERTS.] If the latter have been produced by the gradual extension of the former, we may probably conclude that the permanent accumulation of sand was effected by the continual successive formation of dunes. In all past ages of the earth's physical history, as at the present era, they must have been formed wherever there was sea, together with rocks, the disintegration of which would afford the requisite material, if the form of coast-line, and the nature of its vegetable productions, and the prevalent direction of the winds were also favourable. And accordingly, sandstones of almost every geological age might be referred to containing vestiges of organic matter, lineally disposed, which may have resulted from their consolidation. These are more evident, however, in the later secondary and in the tertiary strata than in sandstones of great comparative antiquity; as might naturally be expected, from the longer exposure of the latter to metamorphic action, and the gradual obliteration of organic impressions by the various processes of alteration in rocks, the operation of which is permitted by the lapse of time.

DUNG. [MANURE.]

DUODECIMALS, a term applied to an arithmetical method of ascertaining the number of square feet and square inches in a rectangular space whose sides are given in feet and inches. For instance, to find the contents of 6 feet 7 inches by 2 feet 5 inches, proceed as follows:

Feet.	Inches.	
6	7	
2	5	
13	2	
2	8	11
15	10	11

In the answer, 15 means 15 square feet; 10 means 10 strips of one foot by one inch, or 10-twelfths of a square foot; 11 means 11 square inches, or 11-144ths of a square foot. This result is obtained as follows:—

2 feet by 6 feet gives	12 square feet.
2 feet by 7 inches gives or 14-12ths of a square foot.	1 „ foot, 2-twelfths,
	13 square feet, 2-twelfths.
6 feet by 5 inches gives or 30-12ths of a square foot.	2 square feet, 6-twelfths,
7 inches by 5 inches gives or 35 square inches.	2-12ths, 11 sq. in.
	2 square feet, 8-12ths. 11 sq. in.

The following instances are perfectly similar:

Feet.	Inches.		Feet.	Inches.
11	10		3	4
12	7		8	6
142	0		26	8
6	10	10	1	8
148	10	10	28	4

DUPLEX QUERE'LA (double querele or complaint), a process in ecclesiastical causes, in the nature of an appeal from the ordinary to his next immediate superior, as from a bishop to an archbishop, or from the archbishop to the crown in council. It seems to have been called double querele, because in its form it is a complaint both against the judge and against the party at whose suit justice is delayed. (Blackst. 'Comm.,' Mr. Kerr's edit., iii. 256.)

DUPLICATE RATIO (λόγος διπλασίων), a term used by Euclid, and defined as follows: If A be to B in the same proportion as B to C, then the ratio of A to C is called the duplicate ratio of A to B. When A, B, and C are lines, the duplicate ratio of A to B is that of the square on A to the square on B; when numbers, that of A times A to B times B. [Ratio; Exponent.]

DUPLICATION OF THE CUBE, the solution of the following problem: to find the side of a cube which shall be double that of another cube. This question, which is insoluble with perfect exactness by the methods of ordinary geometry, attained such a degree of notoriety among the Greek geometers that its origin was the subject of a mythologic fable. Eutocius, in his commentary on the sphere and cylinder of Archimedes, has preserved a letter of Eratosthenes to Ptolemy (Euergetes) in which it is said that one of the tragedians (Euripides, according to Valckenaer, cited by Montucla's editor) had introduced Minos erecting a sepulchre to Glaucus. The architect proposed one hundred palms every way, on which Minos declared that such a size would be too small for a royal sepulchre, and required that it should be doubled in size; and thereupon arose the difficulty. Eratosthenes also states another fable, namely, that the Delians, during a pestilence, had been ordered by the oracle to produce a cubical altar double of one which then existed. They applied to the school of Plato at Athens, who found that the problem eluded all their efforts. Other writers make mention of the latter story, and Valerius Maximus, in particular, adds that Plato referred the querists to Euclid; which must be an anachronism. However this may be, the problem continued to furnish an unceasing object of research; and such was the importance of its solution in the eyes of Eratosthenes, that he hung up his own solution in a temple as an offering, and composed an epigram, of which the principal value now is the proof which it affords that he considered Menæchmus as the first inventor of the conic sections.

Hippocrates of Chios, known as the first who could find the area of a (not *any*) curvilinear figure, perceived, according to Eratosthenes, that this problem could be solved as soon as two mean proportionals could be found between the side of the given cube and twice its length; that is, A being the length of the given cube, and X and Y two lines such that

$$A : X :: X : Y \text{ and } X : Y :: Y : 2A,$$

this geometer saw that X was the side of the cube double of that on A. But the new problem presented exactly the same difficulty as before; various mechanical curves (as they were called) were invented for the purpose; it was found that the conic sections were sufficient, but no solution appeared consistent with the restrictions implied in the postulates of Euclid.

Eutocius has mentioned the solution of Eudoxus, and has preserved those of Plato, Hero, Philo, Apollonius, Diocles, Pappus, Sporus, Menæchmus, Archytas, Eratosthenes, and Nicomedes. Pappus himself (in the third book, the first of those which remain entire) has preserved the solutions of Eratosthenes, Nicomedes, and Hero. In several instances these notices are the only clue which we have to the dates of the investigators, as there is strong presumption that those who are named by Eutocius and not by Pappus lived between the two.

The trisection of the angle [Trisection] offered difficulties of a similar kind, and engaged the attention of several of the individuals above mentioned. That of the quadrature of the circle is altogether of another kind. For the various solutions of the problem of the duplication, see Montucla, 'Histoire des Recherches sur la Quadrature du Cercle,' 2nd edition, Paris, 1831; or Reimer, 'Historia Problematis de Cubi Duplicatione,' Göttingen, 1798; or the works of Eutocius and Pappus already cited.

The importance of this problem declined with the rise of the decimal arithmetic. Many different attempts were made, some avowedly mechanical (as opposed to geometrical), others by those who imagined they could overcome the original difficulty. Any process for the solution was called *mesolabum* (a term as old as Vitruvius). One of the last was that of the celebrated Vieta, containing an error, which is the more remarkable, that little, if any, notice has ever been taken of it. (See his works, Schooten's edition, p. 273.)

DUST, ATMOSPHERIC; DUST-HAZE; DUST-STORM; are terms designating related phenomena, depending on the suspension in the air of congeries of solid particles, which, within about a quarter of a century past have received some definite scientific attention; finely-divided solid matter, derived from the mineral kingdom, together with minute organisms or fragments of animal and vegetable origin, having come to be regarded as forming a proximate element of the lower strata of the atmosphere, regarded in the gross. Their suspension, no doubt, is dependent on the principle of the internal friction of the air, to which Professor Stokes has referred that of the clouds. [Cloud.]

The great pioneer of systematic and scientific micrology, Professor Ehrenberg of Berlin, who has done for a host of the objects of natural history requiring the microscope for their investigation, or even distinct vision, nearly what Linnæus did for all the species of organic nature known to him, which could be examined by the unassisted, or but slightly assisted, eye, has not omitted to extend his philosophic scrutiny and distribution to the motes that float in the air, referring them to their places in nature, or to the creatures from which they have been derived. In 1849, he published collectively the results of the researches on this subject which he had then been pursuing for some years, under the title of 'Dust of the Regular-Winds and Blood-rains,' &c., consisting of 192 folio pages, and containing seven tabular catalogues, and six coloured plates of particles of atmospheric dust as viewed by the microscope. A synopsis of the contents of this work will be found in the 'Pharmaceutical Journal,' edited by the late Jacob Bell, for June 1850, vol. ix., pp. 569–575. From this it appears that the dust of the regular winds yields to chemical examination—silica, alumina, potash, soda, oxide of iron, oxide of manganese, oxide of copper, carbonate of lime, magnesia, water, and organic (combustible) bodies. By microscopic analysis are discerned in it fine quartz sand, still finer yellowish or reddish mould (very fine granular dust, *Gallionella ferruginea ?*), mixed with numerous organic forms and fragments. Generally single isolated fragments of pumice are observed in it, but chiefly green prismatic crystals, as in volcanic tufa and *rapilli*. Likewise white calcareous crystals which readily dissolve in muriatic acid. The organic substances are *Polygastrica*, *Phytolitharia*, *Polythalamia*, and soft vegetable parts. The total number of organic forms observed at this period amounted to 320 species; but many more have since been discovered, and have been described in Professor Ehrenberg's communications to the Royal Academy of Sciences at Berlin, continuing the elaborate investigation of which we here present merely a few results.

Over the island of Teneriffe, as recorded in Professor C. Piazzi Smyth's Report on the astronomical experiment in that locality, in the year 1856—the principal object of which was to ascertain, by following out a suggestion of Newton, how much celestial observation can be benefited by eliminating the lower third or fourth parts of the atmosphere—the existence of atmospheric dust is manifested in a remarkble manner, affecting all the phenomena dependent on the transparency and the transcalescence of the air. When describing the astronomical qualities of the atmosphere at his observing stations on the Peak, and after noticing those arising from the winds and the clouds, he thus describes those which are imparted by the dust: "A more important quality of the atmosphere was caused by the dust-haze, which was ever more or less present, though sometimes in vastly greater quantities than at others, and was precisely that which injured, or rendered impossible, daylight observations of stars (weakening direct light and multiplying general light). Where this dust-haze came from or went we could never tell; but, when present, we could easily distinguish its banks, or strata—dense strata, far above the clouds of the north-east trade-wind—as they stretched away and condensed in perspective towards the horizon. There were often several strata, one above the other, and mutually separated by very clear and sharply-defined spaces of atmosphere. When, as was sometimes the case, the summits of Grand Canary, or of Palma [other islands of the group], rising high above the sea of clouds, pierced also these upper strata of dust-haze, we had from [the observing station of] Guajara, the curious phenomenon of zones of blue mountain alternately distinct and again indistinct almost to invisibility, and yet no cloud or other recognised impurity of the atmosphere intervened. Being above much of this dust, though perhaps not the greater part of it [the elevation of the station being 8903 feet, and the dust-strata rising to not less than 11,000 feet], we were evidently better off than an observer at the level of the sea, when pointing to a zenith object, but for a horizontal one we were worse off, from often being *in*, and then looking *through* the whole plane of the stratum, and so experiencing the maximum of its light-stopping effect. Hence the occasional deterioration of sunrise and sunset were infinitely greater than anything that occurred at noon; and on some days, when the sky was perfectly free from cloud, and the sun had been distressingly hot and bright when high in the sky, yet it had almost become invisible before it set. It was seen, though made out with difficulty on such occasions, through a darkling, yet luminous haze of dull lemon-yellow colour; but what it set behind, or when exactly it did set, there was no ascertaining. The next evening perhaps the atmospheric dust had removed, and the change in the sunset was magical. The orb radiated hot and bright up to the moment of going down. Then, too, in place of the uniform yellow colour of the dusty sunset, the most gorgeous scarlets, yellows, and blues took its place."

From his experiments on the radiation of the sun, Professor Smyth says on this subject, after drawing some important inferences, "Towards the chief astronomical end of the expedition, there is a yet more interesting conclusion to be drawn. The days of highest radiation are those of least temperature, and *vice versâ*: and this difference obtains in a signal degree when there was no visible disturbing action of wind or clouds. What then causes the radiation of one day to be greater than that of another, and the temperature less? The immediate agent appears to be the atmospheric dust," diminishing by its interposition the effect of the solar radiation, but at the same time augmenting the temperature of the air by the multiplied radiation and reflection from its particles, in a manner corresponding to its action upon light as already noticed. "Hence then, we may easily understand why the small difference of altitude [1800 feet] between Alta

Vista [the upper observing station], and Guajara produced as great an increase in the radiation as did the great difference, nearly four times as great, between Guajara" itself, and the town of Oratava at the base of the mountain.

"To eliminate this dusty medium" Professor Smyth concludes, "would be of the utmost consequence to the further improvement of astronomical observation, and may be considered the greatest and most subtile difficulty which the observer has to deal with; and it is probably general over the world, as on the South African mountains, at heights of 5600 feet, the phenomenon was almost at notable as on Guajara. From Dr. Mason's observations of solar radiation in Madeira, and from the relations given to me by inhabitants of Teneriffe, as to the periods of the year when the Peak is seen most clearly, I am disposed to think that there is least of this dust in the atmosphere in the latter end of the winter and the earlier part of the spring." (Report, or 'Phil. Trans.,' 1858, pp. 481, 482, 486–488, 499.)

Professor Smyth found it almost impossible to collect particles of the dust-haze for examination. Some of it, however, deposited at Guajara, he found to be scales from butterflies' wings. He also obtained a specimen of atmospheric dust which had fallen all over the Canarian islands, and another which had fallen at sea. By the microscopical examination of these, with a power of 400 linear, hardly anything could be made out but particles of sand. "The colour of either was mostly an ochry yellow with an occasional bright red, more rarely a green fragment; but nothing organic could be clearly distinguished of a diatomaceous character; the forms of almost all the particles being like quartz rocks in miniature." ('Report,' pp. 570, 571.)

From its characters and the concomitant phenomena, it may be inferred that the haze described in the following extract from Dr. Joseph D. Hooker's 'Himalayan Journals' (vol. ii. p. 409), is the dust-haze, occurring at altitudes in the Himalaya, nearly corresponding to those at which it exists, as we have seen, over the island of Teneriffe, and on the mountains of South Africa. "Two phenomena particularly obstruct radiation in Sikkim—the clouds and fog from the end of May till October, and the haze from February till May. Two months alone are usually clear; one before and one after the rains, when the air, though still humid, is transparent. The haze has never been fully explained, though a well-known phenomenon. On the plains of India, at the foot of the hills, it begins generally in the forenoon of the cold season, with the rise of the west wind; and, in February especially, obscures the sun's disc by noon; frequently it lasts throughout the twenty-four hours, and is usually accompanied by great dryness of the atmosphere. It gradually diminishes in ascending, and I have never experienced it at 10,000 feet; at 7000, however, it very often, in April, obscures the snowy ranges thirty miles off, which are bright and defined at sunrise, and either pale away, or become of a lurid yellow-red, according to the density of this haze, till they disappear at 10 a.m. I believe it always accompanies a south-west wind (which is a deflected current of the north-west) and dry atmosphere in Sikkim."

Hermann Schlagintweit has noticed the diminution of the solar radiation by the dust-storms of India, and observed a peculiar coloration of the sun, which he thinks is their regular concomitant when the air has lost a certain amount of transparency. "In dust-storms," he remarks, "the sky has," as in fogs, "a decidedly reddish colour, which in this case is that of the dust itself, but the sun's disc is blue, a phenomenon evidently connected with the suspension of solid particles in the air. I observed this colour best on the 6th of April 1856, at Futtehpore. The hot wind lasted from 12h. 45m. to 6h. 10m. p.m., and stopped very suddenly after sunset. The sun was very much obscured as early as 1 p.m., and had then assumed this blue appearance so decidedly, that it looked like the sun's disc seen through a dark-blue glass; the shadow of a thin cylinder falling on white paper was nevertheless well defined and reddish, showing that the illuminated paper had received rays of the (complementary) bluish colour. The blue colour of the sun, though the light was gradually diminished, lasted until 5h. 19m. p.m., when the sun had a height only of about 15 degrees; then the disc soon disappeared entirely behind the clouds of dust. . . . . . The temperature of the air diminished with the increase of the wind and discoloration of the air." ('Journ. of the Asiat. Soc. of Bengal,' vol xxv., 1856, pp. 564, 565.) Whatever dependence, however, the blue colour of the sun may have upon the presence of solid particles in such cases, its cause, in other instances, is certainly a particular condition of the aqueous vapour in the air. [Meteors; Meteorology; Volcanoes; Winds.]

DUTCH LIQUID. [Ethyline.]

DUTY. [Right.]

DUUMVIRI, the name given to various magistrates in the republic of Rome, as well as in the colonia and municipia, who were elected in pairs for the discharge of any class of duties. We find the name applied to six different sets of functionaries at different periods. The first duumvirate on record was composed of the two judges of blood (*duumviri perduellionis*), appointed by Tullus Hostilius for the trial of P. Horatius, indicted for the murder of his sister, a crime of so great a nature as to be deserving of capital punishment (*perduellio*). The criminal condemned to death, as the lictor appeared with the fatal cord, claimed his right of appeal to the people, which being allowed him, he was acquitted, as Livy says, by them, "admiratione magis virtutis quam jure causæ." (Liv. i. 26.) This office was exercised by Tarquinius Superbus alone, for tyrannical purposus (Liv. i. 49), and afterwards by the consuls (Liv. ii. 5), who were indeed a duumvirate. Whether these *duumviri* were the same as the *quæstores parricidii*, as Niebuhr supposes, or whether they were distinct official personages during the kingly dynasty, is a question involved in the same obscurity as most other points relating to this period of Roman history. It certainly would appear that the two terms are confounded by ancient writers, some calling the judges appointed to preside at the trial of capital offences quæst. parric. others calling them duum. perduel. (cf. Liv. i. 26, d. 1, 2, 2, 23, and Festus *sub voc. parici et sororium*). But there is no doubt that they were distinct officials after the fall of the kingly power, and in the republican times, for while the one set, the quæstores, were regularly appointed by the year, the others were rarely and only on great occasions summoned to work. (cf. Liv. ii. 41, vi. 20; Dion Cass. xxxvii. 27; Aul. Gel. xvii. 21, and Cic. Pro Rabicio, c. iv. 2.) The *duumviri sacrorum*, who took care of and interpreted the Sibylline Books, were also a very ancient magistracy, ascribed by the old legends to the last Tarquin, and summoned into being on such dreadful emergencies as Livy records. (Liv. iv. 21.) Niebuhr thinks ('Hist. of Rome,' i. p. 504, Engl. tr.) that the number was dictated by a wish to deal evenly with the first two tribes, the Ramnes and the Tities. Besides these there were the *duumviri jure dicundo*, who were the highest magistrates in the municipal towns and colonies (cf. Cic. Agr. Leg. ii. 34, D. 2, 3, D. 15, 1. 3, § ult. D. 47, 10, 13, 5), sometimes called consuls (Cic. in Pison. cxi.), and sometimes even dictator and quæstor. Their jurisdiction, according to Savigny, was, under the republic, unlimited in civil matters, but was restricted within the limits mentioned in the digest and code in Imperial times. The *duumviri quinquennales*, or the censors in the municipal towns; distinct personages from the above magistrates; the *duumviri* specially appointed for the purpose of building or dedicating temples (Liv. i. 28, xxii. 33); and the *duumviri navales*, who were two officers, first elected in the year 436 A.U.C. (Liv. 'Epit.' lib. xii.; Niebuhr's 'Römische Geschichte,' translated by W. Smith and L. Schmitz, edit. 1851, vol. iii. p. 241.) Their duty was to collect, equip, man, and command the fleets of the republic. (Liv. ix. 30; xl. 18 and 26.) At the time of the first Runic war the office no longer existed.

DWARF is a technical term employed by gardeners to distinguish fruit-trees whose branches proceed from close to the ground from *riders* or standards whose original stocks are several feet in height.

DWARFING TREES. Nature, in many respects, can be made to deviate from her ordinary course of procedure, in order to be subservient to the purposes of men. In nothing is this fact more apparent than in the various modes of dwarfing trees.

The trees of our orchards and forests, for example, which grow naturally to a considerable size, can be made to assume all the appearances of maturity and age while only a few feet high; a forest in miniature can thus be created, which has a very grotesque and curious appearance. There are various methods of producing this effect; such as selecting peculiar kinds of stocks and grafting upon them. For example, if the pear-tree be grafted upon the quince stock, or the peach upon the plum, their growth is very much retarded, and their ultimate size is comparatively small; the same effect is produced upon all other trees where there is a difference between the tissue of the stock and that of the scion which has been grafted upon it; or if dwarf varieties be grafted upon stocks of a similar constitution, though taller in growth, the former will still retain their original character. Again, if the branches be bent, and the flow of the sap in any way impeded, or if a quantity of the fibrous roots be cut away, and nourishment more sparingly supplied to the branches, we arrive at the same results.

Sometimes trees are dwarfed by very severe pruning, particularly if this operation be performed in summer; and, although they evidently try for a length of time to overcome this obstruction to their natural size, yet they eventually assume a dwarfed and stunted habit, which, with a little care, may be retained for many years. The Chinese in particular have carried this practice to a great extent, and they ornament their fanciful gardens with miniature forests of elms, junipers, and other timber trees.

The methods of dwarfing employed by the Chinese are the following: young trees of various sorts are planted in flat porcelain vessels, and receive only so much water as is sufficient to keep them alive; in a very short time the pots are completely filled with roots, which, being hemmed in on all sides, cannot obtain a sufficient quantity of nutriment, and, as a matter of course, the growth of the stem and branches is thus impeded. The Chinese also pinch off the ends from the young shoots, mutilate the roots, lacerate the bark, tie down the branches, and break many of them half through; in short, by every means in their power they contrive to check growth, so that, stunted and deformed by these means, the trees soon assume all the marks of age when only two or three feet high.

There is another method of producing dwarf trees, which may be termed accidental: namely, selecting dwarf individuals and obtaining seed from them. It is well known that when the young seed is fertilised by the influence of the pollen belonging to its own flower, or to the same plant upon which it grows, the future progeny so produced partakes generally in a large degree of the nature of the parent from which it originates. Now, if seed be carefully obtained from a variety rather more dwarf than usual, some of the plants produced by that seed will be somewhat more dwarf than their parents. The most dwarfed individuals again selected for seed will originate a race yet more dwarf than themselves; and thus, with patience and by successive generations, a variety only a few inches high may be obtained from a species two or three feet high, or even higher. This is the origin of dwarf roses, dahlias, and other common cultivated flowers.

With the exception of this last-mentioned, method, all the others, however different they may seem, proceed from the same principle; for whether we graft upon stocks whose tissue differs in organisation from the scion, or whether we bend the branches, or cut or confine the roots, we prevent the full flow of the sap in all such cases, and thus advance the age of puberty and bring on a fruit-bearing state. When plants have arrived at this stage of existence, all their energies are directed to the formation of fruit; hence forcing a tree into an early state of fruit bearing is almost synonymous with dwarfing it.

DYEING is the art of staining textile substances with permanent colours. To cover their surfaces with colouring matters removable by daily use would be to apply a pigment rather than to communicate a dye. Dye-stuffs can penetrate the minute pores of vegetable and animal fibres only when presented to them in a state of solution, and they can constitute fast colours only by passing afterwards into the state of insoluble compounds with the fibres themselves. Dyeing thus appears to be altogether a chemical process, and to require for its due explanation and practice an acquaintance with the properties of the elementary bodies, and the laws which regulate their combinations. It is true, nevertheless, that many operations of this, as of other chemical arts, have been practised from the most ancient times, long before any just views were entertained of the nature of the changes that took place. Mankind, equally in the rudest and most refined state, have always sought to gratify the love of distinction by staining their dress, sometimes even their skin, with gaudy colours. Moses speaks of raiment dyed blue, and purple, and scarlet, and of sheepskins dyed red,—circumstances which indicate no small degree of tinctorial skill. He enjoins purple stuffs for the works of the tabernacle and the vestments of the high priest.

In the article CALICO PRINTING we have shown from Pliny that the ancient Egyptians cultivated that art with some degree of scientific precision: seeing that they knew the use of mordants, or of those substances which, though they may impart no colour themselves, yet enable white cloth to absorb colouring drugs. Tyre, however, was the nation of antiquity which made dyeing its chief occupation and the staple of its commerce. There is little doubt that purple, the sacred symbol of royal and sacerdotal dignity, was a colour discovered in that city, and that the discovery and use of the dye contributed to the opulence and grandeur of the place. Homer marks the value as well as antiquity of this dye, by describing his heroes as arrayed in purple robes. Purple habits are mentioned among the presents made to Gideon by the Israelites from the spoils of the kings of Midian. The juice employed for communicating this dye was obtained from two different kinds of shell-fish, described by Pliny under the names of *purpura* and *buccinum;* and was extracted from a small vessel, or sac, in their throats, to the amount of only one drop from each animal. A darker and inferior colour was also procured by crushing the whole substance of the buccinum. A certain quantity of the juice collected from a vast number of shells being treated with sea-salt, was allowed to ripen for three days; after which it was diluted with five times its bulk of water, kept at a moderate heat for six days more, occasionally skimmed to separate the animal membranes, and when thus clarified was applied directly as a dye to white wool, previously prepared for this purpose by the action of lime-water, or of a species of lichen called fucus. Two operations were requisite to communicate the finest Tyrian purple: the first consisted in plunging the wool into the juice of the purpura; the second, into that of the buccinum. Fifty drachms of wool required one hundred of the former liquor, and two hundred of the latter. Sometimes a preliminary tint was given with coccus, the kermes of the present day, and the cloth received merely a finish from the precious animal juice. The colours, though probably not nearly so brilliant as those producible by our cochineal, seem to have been very durable, for Plutarch says, in his 'Life of Alexander' (chap. 36), that the Greeks found in the treasury of the King of Persia a large quantity of purple cloth, which was as beautiful as at first, though it was 190 years old. The difficulty of collecting the purple juice, and the tedious complication of the dyeing process, made the purple wool of Tyre so expensive at Rome that in the time of Augustus a pound of it cost nearly 30*l.* of our money. Notwithstanding this enormous price, such was the wealth accumulated in that capital, that many of its leading citizens decorated themselves in purple attire, till the emperors arrogated to themselves the privilege of wearing purple, and prohibited its use to every other person. This prohibition so much discouraged the art of dyeing purple as eventually to occasion its extinction, first in the western and then in the eastern empire, where, however, it existed in certain imperial manufactories till the 11th century.

Dyeing was little cultivated in ancient Greece. The people of Athens wore, generally, woollen dresses of the natural colour. But the Romans must have bestowed some pains upon this art. In the games of the circus, parties were distinguished by colours. Four of these are described by Pliny,—the green, the orange, the gray, and the white. The following ingredients were used by their dyers: a crude native alum mixed with copperas, copperas itself, blue vitriol, alkanet, lichen rocellus or archil, broom, madder, woad, nut-galls, the seeds of pomegranate, and of an Egyptian acacia.

The moderns have obtained from the New World several dye-drugs unknown to the ancients, such as cochineal, quercitron, Brazil wood, logwood, annatto, &c.; and they have discovered the art of using indigo as a dye, which the Romans knew only as a pigment. But the vast superiority of our dyes over those of former times must be ascribed principally to the employment of pure alum and solution of tin as mordants, either alone or mixed with other bases; substances which give to our common dye-stuffs remarkable depth, durability, and lustre. Another improvement in dyeing of more recent date is the application to textile substances of metallic compounds, such as Prussian blue, chrome yellow, manganese brown, &c.

Indigo, the innoxious and beautiful product of an interesting tribe of tropical plants, which is adapted to form the most useful and substantial of all dyes, was actually denounced as a dangerous drug, and forbidden to be used, by our parliament in the reign of Queen Elizabeth. An Act was passed authorising searchers to burn both it and logwood in every dye-house where they could be found. This Act remained in full force till the time of Charles II.; that is, for a great part of a century. The purpose of this statute was professedly to check the use of two dye-drugs supposed to be dangerous; but it is probable that the legislation was suggested by the growers or makers of certain English drugs, to favour their monopoly.

Mr. Delaval made many ingenious experiments to prove that the particles of dye-stuffs possess no power of reflecting light, and that, therefore, when viewed upon a dark ground, they all appear black, whatever colour they may exhibit when seen by light transmitted through them. He hence inferred that the difference of colour shown by dyed cloths is owing to the white light which is reflected from the textile fibres being decomposed in its passage through the superinduced colouring particles. We think it more than probable that this conclusion is in some respects incorrect, and that the aluminous, iron, and tin bases form combinations with dye-stuffs which are capable of reflecting light, independent of the reflection from the fibre itself. There can be no doubt, however, that this latter reflected light adds greatly to the brightness of the tints, and that the whiter the textile substance is, the better dye it will, generally speaking, receive. It is for this reason that scouring or bleaching of the stuffs is usually prescribed as a process preliminary to dyeing.

Bergman appears to have been the first who referred to chemical affinities the phenomena of dyeing. Having plunged wool and silk into two separate vessels, containing solution of indigo in sulphuric acid diluted with a great deal of water, he observed that the wool abstracted much of the colouring matter, and took a deep blue tint, but that the silk was hardly changed. He ascribed this difference to the greater affinity subsisting between the particles of sulphate of indigo and wool, than between these and silk; and he showed that the affinity of the wool is sufficiently energetic to render the solution colourless by attracting the whole of the indigo, while that of the silk can separate only a little of it. He thence concluded that dyes owed both their permanence and their depth to the intensity of that attractive force.

We have therefore to consider in dyeing the play of affinities between the liquid medium in which the dye is dissolved and the fibrous substance to be dyed. When wool is plunged in a solution containing cochineal, tartar, and salt of tin, it readily assumes a beautiful scarlet hue; but when cotton is subjected to the same bath it receives only a feeble pink tinge. Dufay took a piece of cloth woven of woollen warp and cotton weft, and having exposed it to the fulling-mill in order that both kinds of fibre might receive the same treatment, he then subjected it to the scarlet dye; he found that the woollen threads became of a vivid red, while the cotton continued white. By studying these differences of affinity, and by varying the preparations and processes, with the same or different dye-stuffs, we may obtain an indefinite variety of colours of variable solidity and depth of shade.

Dye-stuffs, whether of vegetable or animal origin, though susceptible of solution in water, and, in this state, of penetrating the pores of fibrous bodies, seldom possess alone the power of fixing their particles so durably as to be capable of resisting the action of water, light, and air. For this purpose they require to be aided by another class of bodies, already alluded to, which bodies may not possess any colour in themselves, but serve in this case merely as a bond of union between the dye and the substance to be dyed. These bodies were supposed, in the infancy of the art, to seize the fibres by an agency analogous to that of the teeth of animals, and were hence called *mordants*, from the Latin verb *mordere*, to bite. But the term derived from it has gained such a footing in the language of the dyer that all writers upon his art are compelled to adopt it.

Mordants may be regarded, in general, as not only fixing but also occasionally modifying the dye, by forming with the colouring particles an insoluble compound, which is deposited within the textile fibres, Such dyes as are capable of passing from the soluble into the insoluble state, and of thus becoming permanent, without the addition of a mordant, have been called substantive, and all the others have been called adjective colours. Indigo and tannin are perhaps the only dyes of organic origin to which the title substantive can be applied, and even they probably are so altered by atmospheric oxygen, in their fixation upon stuffs, as to form no exception to the true theory of mordants.

Mordants are of primary importance in dyeing; they enable us to vary the colours almost indefinitely with the same dye, to increase their lustre, and to give them a durability which they otherwise could not possess. A mordant is not always a simple agent; but in the mixture of which it consists various compounds may be formed, so that the substances may not act directly, but through a series of transformations. The China blue process [CALICO PRINTING] affords a fine illustration of this truth. Sometimes the mordant is mixed with the colouring matters; sometimes it is applied by itself first of all to the stuff; and at others both these methods are conjoined. We may dye successively with liquors containing different substances, which will act differently according to the different mordants successively employed. One solution will give up its base to the stuff only when aided by heat; another acts better and more uniformly when cold, though this is a rarer case.

When a mordant consists of a changeable metallic oxide, as of iron or tin, unless great nicety be used in its application, either no effect or an injurious one may be produced upon the dye. All these circumstances prove how necessary it is for the dyer to be thoroughly versed in chemical science. Each of the great dye-works in Alsace, celebrated for the beauty and fixity of their colours, is superintended in the laboratory department by a gentleman who has studied chemistry for two or more sessions in the universities of Paris or some other eminent schools. The English cotton dyers, twenty or thirty years ago, were far inferior in skill to those of France; but they have recently made great advances. Now many of the Manchester houses have chemists (some of them men of great attainments), and no doubt in other towns also; and for smaller establishments there are professional consulting chemists.

The first principle of dyeing fast colours, we have seen, consists in causing the colouring matter to undergo such a change, when deposited upon the wool or other stuffs, as to become insoluble in the liquor of the dye-bath. The more powerfully it resists the action of other external agents, the more solid or durable is the dye. Generally speaking, a piece of well-dyed cloth should not be materially affected by hot water, by soap and water, by exposure to air and light, by dilute nitric acid, or even by very dilute aqueous chlorine.

In the following details concerning the art of dyeing we shall consider principally its application to wool and silk, having already treated, in the article CALICO PRINTING, of what is peculiar to cotton and linen.

The operations to which wool and silk are subjected preparatory to being dyed are intended, 1, to separate certain foreign matters from the animal fibre; 2, to render it more apt to unite with such colouring particles as the dyer wishes to fix upon it, as also to take therefrom a more lively and agreeable tint, as well as to be less liable to soil in use. The matters foreign to the fibre are either such as are naturally associated with it during its production by the animal, such as have been added to it in the spinning and weaving operations, or such as have been accidentally applied.

Silk is scoured by means of boiling in soap and water, whereby it is freed from a varnish, improperly called gum. This consists of an azotised compound, which may be separated in a gelatinous form by cooling the hot water saturated with it. It constitutes about a fourth part of the weight of most raw silks, and contains a little colouring matter of an orange or yellow hue. When silk is required to be extremely white, either to be woven in that state, or to receive the brightest and purest dyes, it should be exposed to the action of humid sulphurous acid. For dark dyes, silk need not be scoured at all, in which case it preserves its whole weight. Wool is first washed in running water to separate its coarser impurities; it is then deprived of its *yolk* (a species of animal soap secreted from the skin of the sheep) either by the action of ammoniacal urine, by soap and water, or by a weak lye of carbonate of soda. Common wools lose in this way from 20 to 50 per cent. of their weight, and merino wools still more. They receive their final bleaching by the fumes of burning sulphur, or by aqueous sulphurous acid.

Wools present remarkable differences in their aptitude of combining with dye-stuffs, depending upon the different structure of the imbrications of the filaments. The colouring particles seem to insinuate themselves at these pores with greater or less facility, and to be retained with greater or less force, according to the magnitude and form of the orifices. This difference in dyeing, therefore, is not due to the repulsive action of fatty matter, as has been commonly supposed, since it still exists in wool even when every particle of grease has been removed from it by alcohol and ether. A boiling in a solution of bran is often had recourse to, in order to make wool take the dye more readily and equally; but a hot lye containing one-half per cent. of crystallised carbonate of soda answers much better. When heated to the temperature of 140° or 150° Fahr., the wool should be immersed in that liquor, and turned about for half an hour. The wool receives a faint yellowish tint from this bath, but it speedily becomes white on exposure to air; or it may be whitened at once by passing it through tepid water containing a very small quantity of muriatic acid. The yellow colour is most probably occasioned by the reaction of the sulphur and iron contained in the wool.

According to the experiments of Thenard and Roard, alum combines with wool in the state of a salt, without separation of its acid constituent. Wool boiled with a solution of tartar decomposes a portion of it completely; some of the acid and a little of the tartar combine with the wool, while a neutral tartrate of potash remains in the bath. This fact is interesting in reference to the scarlet dye, showing the important part which tartaric acid here performs.

Tinctorial colours are either simple or compound. The simple are black, brown or dun, blue, yellow, and red; the compound are gray, purple, green, orange; and other numerous modifications, all producible by the mixture of simple colours. We shall treat here of only *black* and *brown*, in the present place.

1. *Black*.—If we apply to a white stuff blue, red, and yellow, in certain proportions, the resulting colour will be black. Proceeding on this principle, Castel asserted that 15 parts of blue, 5 of red, and 3 of yellow, will produce a perfect black; but in making this statement he was influenced rather by theoretical than practical considerations. In fact he has afforded us no means of procuring these simple colours in an absolute state. It is undoubtedly true, however, that red, yellow, and blue, employed in adequate quantities, will produce black: because they will together absorb, or obstruct the passage of all coloured light, or, in other words, cause its total privation, whence blackness must result. If we suppose a piece of cloth, to which these three colours have been communicated, but not in such proportions as to produce a pure black, we shall have a tint corresponding to the colour that is in excess; as, for example, a blue, violet, red, or greenish *black*; and with paler tints we shall have a bluish, violet, red, or greenish *gray*.

Gall-nuts, and a salt of iron, so generally employed for the black dye, give merely a violet or greenish-gray, and never a pure black. The pyrolignite of iron, which contains a brown empyreumatic matter, produces a brown inclining to greenish-yellow in light shades, and to chestnut-brown in dark hues. By galling cotton and silk, after a bath of pyrolignite of iron, and repeating the processes several times, a tolerably pure black may be procured. Galls, logwood, and a salt of iron (copperas) produce merely a very deep violet-blue; but if they be applied to wool in a hot bath, with frequent exposure to air, the logwood induces a brownness which is favourable to the formation of black.

The black dye for hats is communicated by logwood, copperas, and verdigris mixed in certain proportions in the same bath; from that mixture there results a vast quantity of an ochreous muddy precipitate, amounting to 25 per cent. of the copperas employed. This mud forms a deposit upon the hats which not only corrodes the fine beaver filaments, but causes both them and the felt to turn speedily of a rusty brown. A well-dyed black hat should retain its original tint as long as it lasts,—a condition seldom realised. Beaver hats, however, to which these remarks refer, have been almost superseded by those covered with silk plush, to which a different process of dyeing applies.

Since gall-nuts give a blue precipitate with the peroxide salts of iron, they are occasionally replaced by sumach, bablah, &c.; but account should be taken in this substitution of the proportions of red or yellow colouring matter in these substances, relatively to the tannin which alone forms the blue precipitate. When a black of the best possible shade is to be given, the wool should be first grounded with indigo, then passed through a bath of logwood, sumach, and protosulphate of iron (green copperas). Sumach and nut-galls may also be employed in the proportion of 6 to 2½; or the sumach may be replaced by nut-galls, if they be equal to one-third of the sumach prescribed. A good black may be dyed upon an indigo ground with 100 lbs. of wool, by taking 200 lbs. of logwood, 60 lbs. of sumach, 2½ lbs. of galls, and 20 lbs. of green copperas; and giving three heats of two hours each to the wool, with airings between. A good black, without an indigo blue ground, may be given to 100 lbs. of wool, by boiling it in a bath of 25 lbs. of alum and 674 of tartar; grounding it with weld and madder; then passing it through a bath of 200 lbs. of logwood, 60 of sumach, and 2½ of galls; taking it out, adding to the bath 20 lbs. of copperas; lastly, giving it three heats of two hours each time.

The best French black, according to Hellot, may be given to wool by first dyeing it a dark blue in the indigo vat; then washing and fulling it; then, for every 50 lbs., putting into the copper 8 lbs. of bruised galls, and as much logwood tied up in a coarse canvas bag, and boiling them for twelve hours. One-third of the bath thus prepared is to be transferred into another copper with 1 lb. of verdigris, and the wool or stuff is to be worked in this solution without intermission for two hours: the bath being kept hot, but not boiling. After taking out the stuff, another third part of the first bath is to be added along with 4 lbs. of green copperas; the fire must be lowered while this salt is being dissolved, and the bath being refreshed with a little cold water, the stuff is to be worked through it for half an hour, and then aired. Lastly, the residuary third of the first bath is to be now introduced, taking care to squeeze the contents of the bag. From 8 to 10 lbs. of sumach are added; the liquor is just made to boil, then refreshed with some cold water; after which, a pound of green copperas being dissolved in it, the stuff is again passed through it for an hour. It is now taken out, aired, washed, then returned to the copper, and worked in the bath for another hour. It is next washed at the river and fulled. A finish is prescribed in the madder-bath.

The ordinary proportions used by the English black dyers for 100 lbs. of cloth, previously treated in the indigo vat, are about 5 lbs. of copperas, as much nut-galls bruised, and 30 lbs. of logwood. They first gall the cloth, and then pass it through the decoction of logwood in which the copperas has been dissolved A finish of weld is often given after fulling; but this is of doubtful utility, especially when a little soap has been used in the fulling-mill. Vitalis prefers the pyrolignite of iron to the sulphate for the black dye, and says it produces a softer and more velvety colour—an opinion which some English chemists dispute.

The black dye vat, as it gets exhausted, is employed to dye grays of various shades.

Silk is dyed black in two methods, according to the market for which it is made. When sold by weight, as was formerly the practice at Tours, and is now with silk thread in this country, it is an object with the dyer to load it with as much colouring or other matter as possible. Sugar is at present much employed to falsify the weight of English silk thread, as any person may discover by applying a hank of it to his tongue. We have seen thread more than doubled in weight by this fraudulent device. Such silk is called *English black* by the French, who are not suffered to practise this deception. When silk is sold by superficial measure, on the other hand, it becomes the dyer's object to give it a black colour with as little weight of materials as possible. Hence the distinction well known in the trade of heavy and light silks. In this, as in many similar examples of adulteration, a desire on the part of some dealers to undersell their neighbours probably produced the evil in the first instance; and then the others joined in the fraud for self-defence.

The 25 per cent. of weight which silk has lost in scouring may be in a great measure recovered by giving it a sufficient dose of galls. For this purpose a bath is made by boiling galls equal to two-thirds or three-fourths the weight of the silk for three or four hours in a sufficient quantity of water, and then letting the decoction settle for two hours. The silk must be steeped in this bath from twenty to thirty-six hours, and then washed in clear water. The first galling is, however, commonly given with a bath somewhat spent; and for heavy blacks generally upon unscoured silk. Several successive immersions in gall-baths, and of considerable duration, are usually given to silk, with intervening washings and wringings at the peg.

The silk dyers keep up from year to year a black vat, often of very complex composition. The essential constituents of the vat are sulphate of iron and gum; but many vegetable matters, as well as filings of iron, are usually added. This bath being heated short of boiling, and then allowed to settle for about an hour, the silks are worked in it with much manipulation, occasional wringing out, airing, and redipping. As the copperas and gum get exhausted, the bath must be replenished with these ingredients in due proportions. The addition of logwood and verdigris is very useful to the black silk dye, and is now generally made. A ground of walnut peels is a good and cheap preparation for this dye.

2. *Brown or dun colour.*—This dye is not so common in England as on the Continent, where the colouring matter is generally produced at a very cheap rate by steeping ripe walnuts with their peels in water for a year or two, till the vat acquires a deep brown colour and a fetid smell. This infusion affords very agreeable and permanent brown tints without any mordant; while it preserves the downy softness of the wool, and requires but a simple and economical process. In dyeing with this infusion, a quantity of it proportional to the shade required is to be put into the copper, diluted with water, and made to boil. The cloth or yarn needs merely to be moistened beforehand with tepid water, to be then plunged in the bath, and turned about till sufficiently dyed. Some dyers, however, give the stuff a preparatory mordant of alum, and leave it to drain for twenty-four hours before subjecting it to the bath of walnut-peels.

Sumach is usually employed in this country to dye fawns, and some browns; but more beautiful browns may be given to woollen stuffs by boiling them first with one-fourth their weight of alum and some tartar and copperas, washing, and afterwards dyeing them in a madder bath. The shade of colour depends upon the proportion which the copperas bears to the alum.

A good brown may also be obtained by mordanting every pound of the stuff with two ounces of alum and one ounce of common salt in a boiling bath; and then dyeing it in a bath of logwood to which some copperas has been added; or the stuff dyed red in the madder bath may be turned about in the black dye vat till the required shade be produced.

The finest browns are produced by boiling each pound of the wool with two ounces of alum, dyeing it in a cochineal bath, and then transferring it to a bath containing a little cochineal darkened with acetate of iron. Instead of cochineal, the archil or cudbear bath may be used, with a little sumach or galls. This forms a cheaper but a more fugitive colour.

A beautiful brown tint, on wool or silk, may be obtained by first giving a pale blue shade in the indigo vat, then mordanting with alum, washing and finishing in a madder bath till the proper brown be brought up. The Saxon blue vat may also be used. If the stuff be mordanted with alum and tartar, then boiled in a madder bath, afterwards in one of weld or fustic, to which more or less copperas has been added, we shall have a mordore, cinnamon, or chestnut brown. By the combination of olive shades with red, bronze tints may be produced. For 25 lbs. of stuff a bath containing 4 lbs. of fustic will suffice. Boil the wood two hours, then turn the stuff in the bath for an hour, take it out, and drain. Add to the bath 4 or 6 ounces of copperas and a pound of madder or sandal-wood; then work the stuff in it till the wished-for shade is attained.

Silk may receive a ground of annatto, and then be dyed in a bath of logwood or Brazil wood, whereby a fine brown tint is obtained. Catechu is used for giving a bronze and brown to cotton goods. [CALICO-PRINTING.] Blue colours are dyed with indigo, Prussian blue, and woad; yellows with fustic, Persian berries, quercitron, turmeric, and weld; reds with archil or cudbear, Brazil wood, cochineal, kermes, lac, logwood, madder, safflower, or carthamus. The purple, green, and orange dyes are produced by various applications of cochineal, indigo, quercitron bark, &c.

M. Roard, long the skilful director of the Gobelins' dye-works, has observed that copper boilers exercise a considerable influence upon delicate dyes. He found that ammonia causes a blue precipitate in the alum bath made in such boilers; while it causes merely a white precipitate in the same bath made in vessels of glass, porcelain, and tin. When wool is kept for some hours in boiling water contained in a copper vessel, it acquires a greenish-gray tint,—a result increased by the ordinary mixture of alum and tartar. If into this bath white wool be plunged, it receives a greenish-yellow, or sometimes an ochrey hue. These observations of M. Roard are of considerable importance, and should lead dyers to employ tin or at least brass boilers instead of copper ones for all vivid colours. Heating with steam, either by double vessels, by straight or spiral tubes, ought on all occasions to be preferred in the dye-house to naked fires, which seldom fail to carbonise some portions of the vegetable or animal matters, and thereby to degrade the colours. The top edge or surface of the boilers should be about 3½ feet above the floor; this being a height which the workmen find most convenient for their manipulations when they stand upon a step 8 or 10 inches high.

The stuffs mordanted with alum should not be transferred to the bath immediately, but be allowed to drain and air for twenty-four hours. The colours are thereby rendered more lively than when dyed soon after the aluming. As experience has proved that an old alum bath is better than one fresh made, it should not be thrown away, but be strengthened or refreshed by the requisite additions of alum and tartar. It is certain that wools boiled in alum the second time, are more beautiful than those boiled in it the first time.

The methods of dyeing black and brown sufficiently explain the general principles, and we therefore conclude with a few observations of a general nature.

Mr. Solly, in communications recently made to the Society of Arts, has drawn attention to several matters having an important relation to the improvement of the art of dyeing. We will merely advert to two of these subjects,—the desirability of studying the chemistry of agriculture in relation to the growth of dye-plants; and the saving of freight in importing only the essential parts of dye-drugs, instead of the whole bulk.

Mr. Solly, in relation to the first of these two subjects, the influence of soil and culture on the chemistry of dye-plants, said, "It was observed that some of the madder grown near Avignon was inferior in the richness and brilliancy of its colour to that produced in other districts. The proprietor being anxious to discover the cause, was led to institute a chemical examination of the soil of his own land, in comparison with that of some of the best madder farms. The result showed that his soil was deficient in lime, while all the others contained it. He was therefore induced to give his land a good dressing of lime; and the result fully justified this course, for in the next year the crop of madder was inferior to none."

The same authority, in relation to the bulkiness of dye-materials, said, "Dye-stuffs are for the most part bulky and heavy substances, the carriage of which for any distance, by land or even by water, makes a very serious addition to their cost; consequently every mode of increasing the proportion per cent. of colouring matter is worthy of consideration; and those modes of preparation are best which yield the largest quantity of colour, and the least quantity of useless fibrous matter. Owing to the judicious manner in which the Chinese safflower is collected, it contains far more of the fine red colouring matter, and is consequently worth four or five times as much in the market as the best Bengal safflower; in addition to which, for want of due care in the drying, the latter is sometimes so much injured during the sea voyage as to be deteriorated fifty per cent. The loss thus sustained is often set down to the nature of the drug, and not to the careless habits of those employed in collecting it. When we remember how many thousand tons of dye-woods are annually imported, and how many thousand tons of it are absolutely useless woody fibre, we cannot help coming to the conclusion that here chemical science might be applied with great advantage; and that if colonists could be taught how to extract and concentrate the true colouring principle of these woods, much unprofitable labour and expense might be spared. Nay, more, the concentrated dye-stuff might be profitably imported from places from which the cost of carriage would altogether prevent the importation of the dye-stuff in its raw state. This is a matter of great practical importance, and one which has not yet received that attention it deserves. There are no doubt difficulties in the way; but after the many triumphs which man has achieved, we surely need not be deterred by any ordinary difficulties."

To the above we may add a few valuable observations, made by Mr. Simmonds in his 'Commercial Products of the Vegetable Kingdom,' on the useful qualities of many simple and well-known plants, and other substances, as dye-materials. "The beauty of the dyes given by common materials, in the Highlands of Scotland, to some of the cloths which were exhibited [at the Great Exhibition of 1851], should lead our botanists and chemists to examine more closely than they have hitherto done, the dye-stuffs that might be extracted from British plants. Woad, and the dyers' yellow wood, are both well known. A piece of tweed, spun and woven in Ross-shire, was dyed brown and black by such cheap and common dyes as moss and alder-bark; and the colours were unexceptionable. Sutherlandshire tweeds and stockings, possessing a rich brown colour, were produced with no more valuable dye than soot; in another piece, beautifully dyed, the yellow was obtained from stony rag; brown from the crops of young heather; and purple from the same, but subjecting the yarns to a greater action of the dye than was necessary to produce brown. There is very little doubt but that beautiful and permanent dyes, from brown to a very rich purple, might be cheaply produced by scientific preparations of the common heather. The inhabitants of Skye exhibited cloth with a peculiarly rich dye, obtained from the Crobal moss."

It has been shown in former articles [Bleaching; Calico Printing] that the legislature has sought to throw a shield of protection around the women and children employed in bleach and print works; that this attempt succeeded so far as concerned print works; but that bleach works still remain exempt from the operation of the Factory Acts. We have now to add that dye works are in the same category as bleach works. In the years 1864-5-6-7, both classes of establishments were subject to many parliamentary discussions, and to inquiries by commissioners—ending by a postponement of all legislation thereon.

DYKE. A structure of earth, or of masonry, for the purpose of resisting the inroads of the sea, or of any large body of water; or for the purpose of guiding and controlling the action of the floods of rivers, or of preventing the tidal action of rivers, or of arms of the sea, from exercising itself in a way which might be injurious to the surrounding lands. The construction and form of dykes must evidently depend to a great extent upon the position in which they are placed, and upon the nature of the materials of which they are to be composed; and the principles to be followed in designing them must equally depend upon the local conditions they will have to fulfil. It will therefore be preferable to treat the whole subject of river or fen-dykes under the head of River Improvements; and that of sea-dykes under the head of Sea Defences.

DYNAM. In estimating the effect of mechanical labour, it is desirable to have some idea of a simple unit well fixed in the mind. All who have studied the subject know the advantage there is in referring every kind of pressure to weight, and measuring it by the weight which will balance it. Thus if one hundred pounds weight will bend a spring into a certain position, we have no difficulty in substituting an opposite force to the weight for the recoil of the spring at the point of application. It is equally convenient to arrive at a distinct notion of a unit of useful effect in the workmanship of machines; but it may not at first be so apparent that the thing is practicable. Nevertheless, the theory of dynamics contains the means of showing that all the effects of a given power are convertible in the following manner. Exclude friction and useless resistances, and suppose that a steam-engine, for instance, will exhaust a certain quantity of fuel in raising a ton through a hundred feet, no power being thrown away. Suppose also that the same machine, with the same fuel, will completely expend the power of that fuel in drawing a certain iron cylinder into wire of a thousand times its length. Then, if a machine could be constructed which acts by the descent of a weight, and draws wire without any loss of power, the descent of a ton through a hundred feet would just be sufficient moving power to draw out the cylinder just mentioned to a thousand times its length. We do not of course mean to say that such freedom from loss of power exists. If, for example, a certain quantity of fuel were made to raise water by a steam-engine, and the water so raised were allowed to fall upon a wheel and grind corn, it is certain that the water would not grind so much corn as the steam-engine itself directly applied to that purpose. But this arises from useless increase of resistances, and from badness of adaptation: it is impossible to make all the water in a fall produce its utmost effect upon a wheel. But what we say is, that were it possible to make adaptation perfect, there exists in the water raised exactly the same capability of grinding corn that there is in the fuel which raised the water.

This being the case, we may consider any machine as simply applied to raising a weight, and look upon the weight raised as a dynamical synonym for any possible effect that the machine could have produced. And the theory further teaches us that the useful effect of any application of power varies jointly as the weight raised, and the height to which it is raised. Thus twice as much power must be expended to raise a double weight to the same height, or the same weight to a double height. Accordingly, the product of the number of pounds raised, and the number of feet to which it is raised, is a *relative* measure of the quantity of power. For example, a certain expenditure of force raises 70 pounds through 20 feet; what comparative expenditure will raise 120 pounds through 210 feet? The product 70 × 20 or 1400 is to the product 120 × 210 or 25,200 in the proportion of 1 to 18; accordingly, the second work requires 18 times the power of the first. Whether it shall be done by 18 engines, or by an application of 18 times as much power to one engine, is merely a question of adaptation.

We can convert the above relative measurement into an absolute form by assuming as a unit one pound raised through one foot; let this be called a *dynam*, or dynamical unit. Thus in the first job above mentioned, there are 1400 dynams of work to do. Whether it be considered as 1400 pounds raised through one foot, or one pound through 1400 feet, or 100 pounds raised through 14 feet, &c. &c., matters nothing: it is 1400 times as much work as one pound raised through one foot. Thus, what is commonly called a *horse-power* is meant by our engineers to signify 550 dynams in a second; a steam-engine which can raise one pound through 550 feet in every second is said to be of *one-horse power*.

This term was introduced by French writers, who called the effect of a cubic metre of water raised through one metre, a *dynamic* or *dyname*. Dr. Whewell ('Mechanics of Engineering,' 8vo, p. 150, Cambridge, 1841,) proposed to naturalise the term *dynam* as applied to our most convenient units, the pound and the foot.

It is for want of a distinct notion of this kind that many persons fall into the error about force and its effects, which lead them to contrive perpetual motions. But independently of this, there is a great practical utility in having a specific name for a quantity of work done, independently of all incidental circumstances; for something which should allow us a proper expression for the result of a quantity of fuel or other generator of force without the necessity of describing a particular mode of using the force. Watt was really the first who assumed, as a dynamic unit, the simple notion of one pound raised one foot; but he did not venture on a name, though the now common term, the *duty* of an engine, first used by him, has reference to the number of such simple units as may be obtained from the engine.* The late Davies Gilbert, in his paper 'On the expediency of assigning specific names to all such functions of simple elements as represent definite physical properties' (Phil. Trans., 1827), proposed to represent the product of the pounds raised and the feet through which they are raised by the term *efficiency*. But he did not go further, and assign a name to the unit of efficiency. This simple step, which is of more importance in the propagation of clear ideas than many persons will think it to be, is due to the French writers.

DYNAMETER. [Micrometer.]

DYNA'MICS (*δύναμις*, force), a word of comparatively modern use, now universally adopted as signifying the science of matter in motion, as distinguished from *statics*, which relates to matter at rest. Under so general a term, our plan requires us simply to refer the reader to the several articles connected with the subject.

Dynamics may be divided into two distinct parts: the mathematical consideration of motion, without reference to any connection with its cause; and the experimental investigation of the connection between pressure and the motion produced by it, together with the mathematical exhibition of the laws under which the second is a consequence of the first. But for the purposes of classification, dynamics is better subdivided into (1) dynamics of a *particle*, and (2) dynamics of a *rigid body*. When the moving matter is considered as condensed into a single *particle*, the laws of its motion may be very accurately and conveniently traced under the following heads:—

(1.) The laws of motion—absolute and relative.
(2.) Collision and impact of moving particles.
(3.) Motion down inclined planes.
(4.) Motion under the action of central forces.
(5.) Curvilinear motion, as of projectiles.
(6.) Motion in resisting media.
(7.) Constrained motion, or motion of a particle along curved tubes, wires, &c.

But if the body be necessarily of some magnitude, and if it be rigid, that is, if its component particles, or its component parts (if it be a system), be supposed to bear, throughout the action, the same invariable position with respect to one another, then we have the following subdivisions of the dynamics of a *rigid body*:—

(1.) Motion about a fixed axis, as of pendulums.
(2.) Motion about a fixed point.
(3.) Motion of a *free* rigid body.
(4.) Motion of a rigid system.
(5.) Motion under the action of impulsive or instantaneous forces.

By referring therefore to such articles as Collision; Motion;

---

* Or rather, according to Watt's view, the *power* is the quantity of work which an engine can perform in a given time; the *duty* is the quantity which it can perform by a given expenditure of fuel.

MOTION, LAWS OF, &c. &c., the details of each subdivision will be clearly understood from the mathematical proofs and explanations there given. The history of dynamics is particularly connected with the names of Galileo, Huyghens, Newton, D'Alembert, and Lagrange, whose lives are given in the BIOG. DIV. See also on this point MECHANICS, the general term under which statics and dynamics are included.

DYNAM'OMETER (δύναμις and μέτρον, measurer of power), a term which has been applied to an instrument which measures any thing to which the name of power has been given, whether that of an animal, or (to take a very different instance) of a telescope, only in the latter case it is termed a *dynameter*. [MICROMETER.] We have also seen the incorrect term *dynometer*.

Dynamometrical instruments have been but little attended to in this country, but they have been used successfully in France for determining the best conditions, with respect to economy of power, under which machines may be constructed and worked. The sagacity of Watt led him to appreciate the importance of a dynamometrical machine, and he constructed his *indicator* for determining the work performed by the steam on the piston of a steam-engine during any single stroke. Prony's Friction-Break measured the work by which a shaft was driven when all other work was thrown off it. In the later constructions, however, the object has been to determine the work transmitted to the whole or any part of a machine, not for a single stroke of the piston, but continuously through any given period, and that without absorbing the whole work to be measured as the friction-break does, but while the machine is performing its usual work. Dynamometers of this kind have been contrived almost entirely by French engineers, and an account of them will be found in the 5th edition of Col. Morin's 'Aide-Mémoire de Mécanique Pratique,' and we may also refer to the 'Leçons de Mécanique Pratique,' of the same author. A good concise statement of the principles of these instruments is given in Nichol's 'Cyclopædia of the Physical Sciences,' 1857, and a detailed description of the dynamometer as originally invented by General Poncelet, and constructed under the direction of Colonel Morin, is given in Tomlinson's 'Cyclopædia of Useful Arts,' Introduction, p. clii.

In the Great Exhibition of 1851, the Jury of Class V. (Machines for Direct Use,) were assisted by Morin's Dynamometer in examining and reporting upon a number of machines exhibited, in which the same object was sought to be attained by various modifications and combinations of similar parts. There were several kinds of dynamometers exhibited, such as the *Dynamomètre de Rotation* for determining the work transmitted by a revolving shaft. There was also a dynamometer for determining the manual labour of driving the handle of a pump or crank: also a dynamometer for registering the work of the steam on the piston of an engine, through any number of strokes; this was constructed on the principle of the constant indicator [INDICATOR] made for the British Association of Science, and described in their Report for 1841.

The principle upon which an efficient dynamometer depends may be briefly stated: We may regard *force* as something instantaneous; or changing, or beginning, or ceasing at any moment; and *work*, as the operation of forces through spaces of time. Thus, if a body be pulled along a level road, force is exerted every moment, and if we pull another body with half the force over twice the distance, the same amount of work will have been performed. Work then depends on the force applied, and the space through which a body subjected to the force moves, and an efficient dynamometer measures the work in any case of resistance overcome and motion produced. The work will be measured by the product of the force (if kept uniformly acting) into the space through which it acts, and the instrument must measure both these quantities—the force and the space.

The original dynamometer simply determined the value of the force as in the instrument invented by Grahame and improved by Desaguliers, for ascertaining the relative strength of an individual at different periods of life and in different states of health. It consisted of a steel yard mounted in a wooden frame, and the strength of an individual was measured by acting on the short end of the lever, so as to produce equilibrium, and the position of the weight on the long arm served as a measure. An instrument by Leroy consisted of a metal tube 10 or 12 inches in length placed vertically on a foot, like that of a candlestick, and containing a spiral spring, and above it a graduated shank terminating in a globe. The shank, together with the spring, retreated in the tube in proportion to the weight acting upon it, and thus pointed out in degrees the strength of the person who pressed on the ball with his hand. Regnier's dynamometer consists of a steel spring bent into the form of an ellipse, and furnished with a semicircular plate of brass for receiving the scales or graduated arcs; these are fastened to one limb of the spring by means of a piece of steel, while to the other limb is attached a small steel support with a cleft at its upper extremity for receiving a small copper lever, which gives motion to the index needle on the scale. The scale is subdivided by hanging known weights to one of the extremities of the spring. Any force acting in the direction of the longer axis of the ellipse tends to flatten it, and giving motion to the lever, the needle moves over the scale, and shows the amount of force exerted. In trying the strength of the human body, the feet are placed in a kind of rack, to which one end of the dynamometer is attached, while the other end is furnished with a double handle, and the person under trial exerts the strength of the reins of his body in compressing the ellipse, the amount of force exerted being shown by the index. In determining the strength of the hands or the muscular force of the arms, the person holds the two sides of the spring nearest to the centre, and exerts his force in flattening the ellipse. In ascertaining the strength of animals the instrument is attached to a fixed obstacle, and the animal is yoked to the other extremity. [ANIMAL STRENGTH.] There are various other forms of dynamometer of this kind for determining simply the value of the force, without reference to the space through which it acts, and this would be sufficient if the force were constant, for all that would be necessary would be to measure the whole space and the one force; but as working forces are by no means constant, but are subject to frequent variations during the times when it is required to measure the work, we must take the small spaces in which the forces are tolerably constant, and multiply them by the forces which act as they move through these spaces, and by summing up the amounts of work contained in each, arrive at the total value.

We shall be able to understand how both results are obtained by the following detailed description of Morin's dynamometer. When applied to measure the mechanical force transmitted by a wheel or pulley intervening between a source of power and the machine which is to be tested, the form of the instrument is that represented in *fig.* 1 (*figs.* 2 and 3 being parts of the same instrument in different points of view),

Fig. 1.

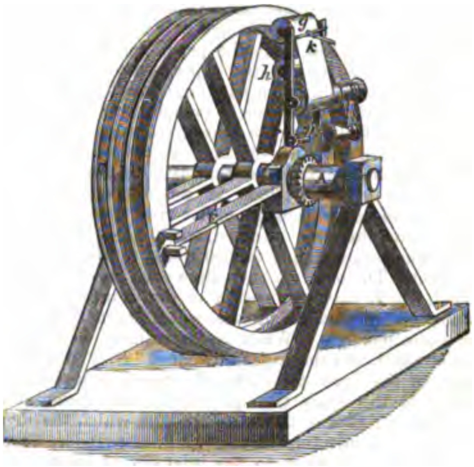
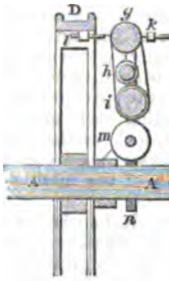
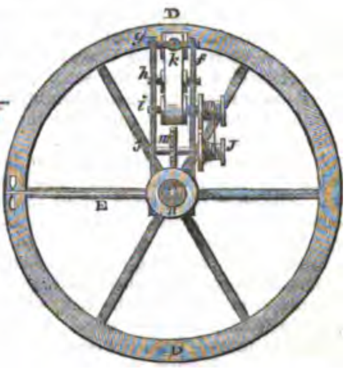


Fig. 2.



.g. 3.



in which A is a stout axle of iron, turning freely in its bearings, and carrying a pulley or drum C. This pulley is keyed to the axle, and turns with it, while a second pulley D, is placed on the same axle, but is not fixed or connected therewith, except by means of the spring E. One end of this spring is attached to the axle, while the other is held firmly by two cheeks projecting from the side of the loose pulley D. Now it will be evident that if any resistance act on the pulley C, to prevent it from rotating, and a force be applied to D to overcome such resistance, the force could only act on C, by means of the spring E, which would be bent until its resilient tendency became just equal to the resistance acting upon C. The pulley D not being connected with the axle, except through the spring E, transmits force only by the flexure of the spring, so that if the resistance on C were continuous, such as would arise from C being made to drive a machine, and the power used to set such machine in motion were applied to D, the spring would maintain a flexure corresponding to the resistance operating on C, and as this resistance varied from one moment to another, so would the flexure of the spring vary to accommodate itself to the working force which was actually passing through the dynamometer. Now, if means were contrived for accurately recording the varying flexures of the spring, we should have a complete indication of the varying power expended during any given time, during which the machine to be examined was under trial. To accomplish this, there is attached to the boss which holds the heel of the spring E, a frame-work *f*, which supports a series of roller *g h i*, a fusee J, and a pencil-holder *k*, while on the edge of the pulley D is a second pencil-holder *l*. In using the dynamometer a long ribbon of paper is wound on the roller *h*, and its outer end being carried over the roller *g* is made fast to *i*. The roller *i* is driven by a string passing from it over the fusee J, which bears on its axis a wheel *m*, in gear with another wheel *n*, situated on the axis A. It will be seen that when by the revolution of the dynamometer axis the wheel *m* is turned, the string will gradually wind upon the fusee J, and the paper will be drawn from the roller *h* over *g*, and be coiled upon *i*. The use of the fusee and string is to give a uniform rate of motion to the paper, notwithstanding the continually increasing diameter of the cylinder *i*, upon which it is being wound. The two spring pencils, *k* and *l*, are so adjusted that their points may press lightly on the paper-ribbon, and so long as the spring E remains unbent, the pencil points are exactly opposite to each other, and they trace only a single line on the paper. The teeth of the wheels *m* and *n* are cut slantingly, so that one will drive the other when placed in planes perpendicular to one another. These details being understood, let the dynamometer be set in action, and the spring E being more or less bent, the pencil-point *l* will be carried to the right or left of *k*, and as the paper is drawn under these pencil points by the action of the string winding upon the fusee J, the pencil *k* on the frame *f* continues to trace a straight line on the paper, while the other pencil *l* attached to the wheel, traces a curved line at distances from the straight line varying exactly as the flexure of the spring, and therefore exactly as the driving force transmitted by the dynamometer varies. There is a contrivance by which the observer can in an instant, engage or let free the toothed wheel *n*, so as to make it drive the other wheel *m*, which gears into it, or when let free the two wheels are simply carried round by the axis, without any relative motion. The observer then allows the paper to move during a given period, which may comprise a certain number of seconds, or a given number of revolutions of the wheel, or a certain number of strokes of a steam-engine. When the experiment has been made the machine is stopped, and the paper unwound. Now it is evident that the lengths of the lines traced by the pencil points bear a certain definite ratio to the space through which the circumference of the pulleys has moved; that is, the space through which the driving force has acted; while the distance of the two lines asunder, bears at every moment, a definite proportion to the intensity of the force which has been passing through the machine. The first of these is the measure of the abscissa of the curve traced, while the ordinate of the curve drawn at any part, represents the force acting at the corresponding moment of the experiment. Hence the area of the curve gives the product of the amount of force acting continually by the space through which it acts; that is to say, it gives the exact quantity of *work* which has passed through the dynamometer into the machine under examination. A corresponding observation having been made of the useful effect yielded during the same period, such as the number of pounds of water raised to a given height, an exact measure is obtained of the ratio of these two results, and the *duty* of the machine under examination is accurately determined.

There is another mode of registration, in which the wheel *n*, instead of driving a fusee is made to turn a small plane disk covered with hard leather. The edge of a small wheel presses lightly on this disk, and attached to the axis of the wheel is a registering train like that of a gas meter. The leather disk is attached to the frame *f*, and the steel wheel to the pulley D. The wheel is so adjusted that when the spring is not bent, the edge of the wheel shall press exactly on the centre of the disk, so that in this position the disk, when driven by the wheel *n*, has no tendency to turn the steel wheel; but when the spring is bent, the steel wheel is moved from the centre of the disk towards the circumference, and the friction thus produced between its edge and the surface of the disk causes the steel wheel to be driven at a greater or less speed, according to the relation between its own diameter and the diameter of that circle on the disk on which its edge may happen to be pressing. In this way the extent of rotation of the steel wheel is a measure of the product of the intensity of the acting force by the space through which it acts, and this being registered during any given period, gives one of the values required for the determination of the *duty* sought.

This apparatus is remarkably accurate in its results: it can be readily applied to any machine, so as to furnish the most valuable information both to the maker and to the employer of machinery. Every set of observations made with this dynamometer furnishes a manufacturing *constant* of great value in determining the cost of production under widely different circumstances. The instrument has been used for determining the power transmitted by machinery from steam-engines and water-wheels, and also for ascertaining the value of manual labour as applied to the working of pumps and driving machinery by cranks. It has also been applied to estimate the traction of horses; and every effort of a team through successive days of labour has been measured and recorded, and the work expended on such efforts numerically estimated. In comparing the various modifications of machines, some surprising differences in the results have been attained, showing how very important it is that the use of this instrument should be more widely extended. The special circumstances of each case may require modifications in its form, and in measuring forces of high inteusities additional springs may be required in the other sides of the boss, and connected with the pulley D. In the Great Exhibition of 1851 were various forms of dynamometer, some of which are noticed in the 'Jury Report,' Class X., and also Class V.

DYSENTERY (Δυσεντερία, *dysenteria*, from δύς, *with difficulty*, and ἔντερον, *intestine; difficultas intestinorum, bloody flux*), a disease in which there is difficulty and pain in passing the stools, which consist of mucus and blood, containing little or no fæculent matter, and generally attended with fever. The desire to evacuate the bowels is frequent and urgent; but the effort is accompanied with severe pain, and is often altogether ineffectual, constituting the affection called tenesmus. What scanty stools are passed consist, as has been stated, of mucus mixed with blood, or of pure blood in considerable quantity; and if any fæculent matter be present, it is commonly in the form of round and hard balls called scybalæ. There is always griping pain in the abdomen. More or less fever is invariably present. The seat of the disease is chiefly in the minute glands of the mucous membrane of the large intestines, and is essentially of an inflammatory character.

The forms of this disease, the causes which produce it, the circumstances under which it prevails, the pathological conditions on which its essential characters depend, and its degree of intensity, are infinitely various; and these modifying influences cause it to assume at different seasons, in different climates, and in different constitutions, the most diversified aspects. It is sometimes a primary, sometimes a consecutive, and sometimes a symptomatic disease. It is now sporadic, now endemic, and occasionally both endemic and epidemic. It is sometimes inflammatory and sthenic, at other times typhoid and asthenic, at one time acute, and at another chronic. These differences are attended with essential differences in the nature of the disease, which not only communicate to it different external aspects, dependent on different internal conditions, but which require totally different remedies.

This disease has been at all times one of the great scourges of our fleets and armies. It occurs equally in hot and temperate climates, and seems to depend more on irregularities of diet and habit than on climate. "During the Peninsular war, the first Burmese war, and the late war with Russia, dysentery was one of the most prevalent and fatal diseases which reduced the strength of the armies."

In the acute form of dysentery, when purely inflammatory, and when mild in character, constipation commonly precedes for some days the attack of diarrhœa. The liquid and frequent stools which at length succeed to this state of constipation soon become streaked with blood; the griping pains which accompany the evacuations, and the straining and tenesmus which follow them, are often attended with distinct chills. The stools may be from eight or ten to sixteen or twenty in the twenty-four hours. The pulse is commonly quick and small, the tongue loaded, and the appetite little impaired.

When the attack is more severe, it is generally attended at the very commencement with diarrhœa, often accompanied with nausea and vomiting, quickly succeeded by scanty, mucous, or gelatinous stools, streaked with blood, preceded by tormina, and followed by tenesmus. The pain in the course of the large intestines may be either severe, or it may not be urgent, but rather a sense of heat and aching than acute pain. Pain, however, is always induced by full pressure over the tract of the colon; and if, in any particular part of this tract, there be urgent pain, some degree of fulness may generally be perceived there. The progress of the disease is indicated by the increasing severity of all the symptoms, and more especially by the increasing frequency of the stools, by the increasing tormina and tenesmus, and the augmentation of the general febrile symptoms. It is not uncommon for from twenty to forty efforts at stool to be made in the twenty-four hours, with the effect of passing only a very small quantity of mucus and blood. In all cases the evacuations are exceedingly offensive; in the worst they are of a cadaverous odour, and the clots of blood are sometimes mixed with pieces of coagulated lymph or fibrin.

In hot climates the disease is still more intense. The heat, the tormina, and the tenesmus, are more urgent and distressing; the thirst becomes excessive, the urine scanty or altogether suppressed, the stools slimy, streaked with blood, and attended with *prolapsus ani*, or watery and ichorous, "resembling the washings of raw beef, in which float particles or even large shreds of coagulable lymph, thrown off from the acutely-inflamed surface." In these cases the prostration of strength is extreme, and is increased by most distressing and exhausting vomiting. When, as sometimes happens in this form of the disease, portions of the mucous coat of the intestine slough away, the countenance of the patient is sunk and cadaverous, and the odour of the stools, and in some degree, indeed, of the whole body, is putrid.

In the asthenic form of dysentery, the tormina, tenesmus, and mucous and bloody stools are attended with great depression of all the organic functions, and extreme prostration of strength. The local dysenteric symptoms, exceedingly urgent from the commencement, are rapidly followed by fever of a low nervous or typhoid type. This form of the disease often prevails as an epidemic; and under circumstances favourable to their accumulation and concentration, exhalations from the stools of the sick seem capable of producing dysentery in persons directly exposed to them, previously in a state of sound health.

Dr. Aitken, who saw this disease in the Crimea, says, "It is the mucous membrane of the great intestine, and especially of the rectum and lower portion of the colon, which is the seat of the characteristic lesions in dysentery." These lesions are frequently attended with an exudative process, which involves the whole mucous membrane, although in a number of cases only the solitary and tubular glands are involved. The following are the morbid conditions of the intestine observed by Dr. Aitken. 1. Forms of exudation obvious on the surface of the mucous membrane of the rectum and colon. 2. Forms of exudation not obvious to the unaided eye, but which were seen in all the cases examined by the microscope, to fill the mucous tubular follicles of the large intestine. 3. Forms of exudation obvious to the eye and demonstrable by microscopic examination, as being developed in the solitary vesicular glands of the large intestine. 4. Changes in the exuded material which tend first towards its organisation and subsequently to its destruction and removal by ulceration. 5. Ulcerative changes in the tissues of the mucous membrane itself. 6. Similar dysenteric lesions extending into the small intestines." In chronic cases the exuded matter is either thrown off or it becomes organised, and subject to the ulcerative process in the same manner as the mucous membrane. In all cases the solitary and tubular glands appear to be first attacked.

The duration of dysentery is as various as its types. It may prove fatal in a few days or hours, or last for weeks and even months, and ultimately destroy life by inflammation and gangrene of the bowels. In some cases the disease ceases spontaneously, the frequency of the stools, the griping and the tenesmus gradually diminishing, while natural stools return; but in other cases, the disease, with moderate symptoms, continues long, and ends in protracted and exhausting diarrhœa.

The causes which predispose to dysentery appear to be long-continued exposure to a high temperature, or alternations of heat and cold; hence the disease is generally most prevalent in summer or autumn, after considerable heats have prevailed for some time, and especially after very warm and at the same time very dry states of the weather. All observation and experience show that a powerful predisposition to the disease is formed by the habitual use of a high and stimulating diet, and especially by indulgence in spirituous liquors, by excessive fatigue, by exposure to night air, by salt diet, and by all causes which enfeeble the constitution in general, at the same time that they over excite the alimentary canal in particular.

The exciting causes are long-continued exposure to intense heat, or to sudden and great alternations from heat to cold; exhalations from vegetable and animal matters in a state of decomposition, as from marsh, stagnant, river or sea water, from animalculæ and minute insects, or from the flesh of deceased animals; noxious exhalations from the bodies of persons crowded together in close and confined situations, and more especially, as would appear, from the discharges from the bowels of persons labouring under dysentery; scanty and bad food, consisting more especially of vegetable or animal matter in a state of decay, as tainted meat, stale fish, unwholesome bread, unripe rice, rye, and impure water.

In the acute form of dysentery, when the fever is high, the pain intense, and the inflammation active, blood-letting from the arm has been recommended, and also the local abstraction of blood by leeching or cupping. The employment of purgative remedies in dysentery requires the greatest discrimination and caution. If the colon be distended with feculent matter which it cannot discharge, no remedies will succeed until this accumulation is removed; if, on the contrary, there have been already frequent and copious discharges of feculent matter, the administration of purgatives should be avoided. The practitioner should therefore carefully examine the state of the bowels with regard to their fulness or emptiness of fæcal matter, and their actual state in this respect can almost always be ascertained with a great degree of certainty if due pains be taken to discover it. If there be reason to suppose that there is any accumulation of fæces, the mildest purgatives should be given, of which the best is castor oil, and this should be cautiously repeated until the irritating matter is wholly removed. Great relief is at the same time afforded to the distressing tormina and tenesmus by emollient and opiate enemas injected in very small quantities. After the subdual of the inflammatory state by blood-letting, and the evacuation of the accumulated fæces by mild purgatives, the great object is to soothe the irritated membrane by opiates, on the judicious employment of which, and the skilful combination and alternation of this class of remedies with mild purgatives and astringents, the successful treatment of ordinary dysentery mainly depends. The asthenic forms with typhoid symptoms need a guarded yet active treatment, nearly the same as that which is proper to typhus fever with abdominal affection. [Fever.]

DYSLYSINE. [Cholic Acid.]

DYSLYTE. A nitrogenous product not yet analysed, obtained by the action of nitric acid upon citraconic acid. It is produced simultaneously with *eulyte*.

DYSPEPSIA (Δυσπεψία, *dyspépsia*), *Indigestion*, the difficult and imperfect conversion of the food into nutriment. Digestion is a part of the great function of nutrition; its ultimate object is to convert the aliment into blood. Between the articles taken as food and the nutrient fluid of the body—the blood, there is no obvious analogy, and there is a wide difference in nature. Hence the function of digestion consists of a succession of stages, at each of which the food undergoes a specific change. Each change is effected by a peculiar process, for the accomplishment of which a special apparatus is provided. Of these processes the chief are mastication, deglutition, chymification, chylification, and fæcation. [Digestion, in Nat. Hist. Div.] The healthy condition and the natural action of every individual organ belonging to the portion of the apparatus proper to each of these processes is necessary to the sound state of the function of digestion. It is easy therefore to see by how many causes it may be disturbed; in how many different organs the source of the disturbance may have its seat, of how varied a nature the disturbance may be, and how greatly the disturbance of the digestive function may derange the other functions of the body.

In the history of the human family there is no known community of human beings in any country, and no age of human life, in which the first necessity of existence, that of taking food for the nourishment of the body, is not the cause of disease and death to great numbers, and of uneasiness, nay, sometimes even of intense pain, to far greater numbers. Why is this? Why is the digestive process more productive of suffering, disease, and death in man than in the lower animals of a similar structure, in which the function, considered in a physiological point of view, is scarcely at all less complex? The correct answer to this question would include a clear account of the causes of dyspepsia, and would suggest the appropriate remedies for the disease.

Digestion being an organic function, when this function is healthfully performed, for reasons which have been fully developed, it is unattended with consciousness. The first effect of the disturbance of this function is to render the patient not only conscious, but painfully conscious, that he has a stomach. A sense of nausea, sometimes, when the affection is severe, even vomiting, an obscure feeling of uneasiness, fulness, distension, weight in the region of the stomach, occasionally amounting to pain, and even severe pain, flatulence, eructation, a sensation of sinking, and lastly, a loss of appetite, constitute the train of uneasy sensations which, coming on after the reception of food, indicate disordered digestion, and which take the place of the feelings of refreshment and exhilaration which result from healthy digestion.

When these uneasy sensations are occasioned by a disordered state of the stomach, the disorder may consist in a derangement either of its secreting arteries, or its mucous glands, or its organic nerves, or its muscular fibres, inducing a deficient secretion of the gastric juice, a deficient secretion of mucus, a diminished or increased irritability of the muscular fibres, by which the motions of the stomach are disturbed. If the gastric juice be deficient, the first step in the digestive process cannot take place, the food cannot be dissolved; if the mucus be excessive, the contact of the gastric juice with the food may be prevented: if the muscular fibres of the stomach are torpid or too irritable, the food may be detained too long or too short a time in the stomach.

The causes of dyspepsia are either those which act directly and immediately upon the stomach itself, or those which act upon the whole body or upon particular parts of it, but which still affect the stomach principally and almost solely.

Of the first kind are noxious, irritating, and indigestible substances taken into the stomach as articles of food or drink, such as tainted meat, decayed vegetables, unripe fruit, very acid matters, ardent spirits, &c.; and even wholesome food taken too frequently or in too large a quantity, especially when its nature is very nutritious, as when it consists principally of animal matter, or when a large quantity of nutriment is presented to the stomach in a very concentrated form, or is rendered too stimulating by being highly seasoned; the abuse of fermented and spirituous liquors, which is one of the most frequent causes of dyspepsia in its severest and most fatal forms; and large quantities of fluids, habitually taken at too high a temperature, as very hot tea, coffee, or soup.

Of the second kind, or the causes which act upon the whole body or upon particular parts and functions of it, are—want of pure air; hence the frequency of dyspepsia in large and crowded cities, and more especially in narrow and confined lanes and alleys, in the dirty and ill-ventilated houses of the poor. Want of exercise: from physical inactivity all the organs of the body languish, but the stomach first and most. Intense study or close application to business too long continued, implying both want of air and want of exercise. Mental emotion, more especially the depressing passions, fear, grief, vexation, disappointment, anxiety, and hope deferred. Exposure to the influence of cold and moisture. In persons with weak stomachs and delicate skins, a cold damp day, more especially suddenly succeeding a hot day, often produces a severe attack of dyspepsia. Hence it is that dyspeptic complaints are so prevalent when cold and damp weather first sets in. Cold is a sedative to the nervous system, as heat is an excitant; and the depressing effects of cold seem to be peculiarly manifested in the nerves of the stomach. Excessive discharges from the body, as flooding, leucorrhœa, large bleedings from the arm, profuse and long-continued sweating, and above all protracted suckling. It is a common practice among the poor in this country to suckle their children too long. A feeble woman is often seen with a strong child at her breast a year and a-half or two years old. The effect upon the constitution of the mother is most pernicious. Emaciation, sharpness of the features, with a peculiar expression in the countenance of languor and exhaustion, a sense of sinking at the pit of the stomach, dimness of sight, giddiness, spectra of different kinds dancing before the eyes, headache, with a small, quick, and sometimes almost imperceptible pulse, and total loss of appetite, are the peculiar characters of this variety of dyspepsia.

The state of dyspepsia is most frequently a state merely of disordered function, without any appreciable change of structure in any of the tissues of the stomach. But all the symptoms of dyspepsia are produced in their intensest degree when they arise from some organic disease of the stomach. Of these the most frequent is inflammation of its mucous coat. This inflammation may be either acute or subacute. When acute, the nature of the malady is indicated by characters so striking that it cannot be overlooked; but the subacute form often exists for a long period quite unsuspected, producing violent and obstinate dyspepsia, which is often greatly aggravated by the remedies employed to remove the complaint. The diagnostic sign of this form of the disease is tenderness on pressure in the epigastric region. In scirrhus of the pylorus and ulceration of the mucous glands of the stomach, organic disease not of unfrequent occurrence, there is superadded to the ordinary signs of dyspepsia a peculiar train of symptoms scarcely to be overlooked or mistaken.

But dyspepsia is often the result of disease situated not in the stomach, but in some other organ. The stomach has been justly called the centre of sympathies, and there is scarcely any disorder of the body which does not affect the functions of the stomach in a greater or less degree. The organs the diseases of which are most apt to produce disorder of the stomach, are the liver, the spleen, the uterus, the kidney, the bronchi, and the skin. In this secondary form of dyspepsia, the disease cannot be removed unless the seat of the primary affection, and the true nature of that affection, be ascertained.

The stomach is the organ in which chymification is effected. Chylification is accomplished in the duodenum, and completed in the jejunum, ilium, and mesenteric glands; and the highly important part of the digestive process, that which consists in eliminating and carrying out of the system the non-nutrient portion of the aliment, is performed by the large intestines. Each of these organs may be the primary seat of disease, giving rise to the ordinary symptoms of dyspepsia; but to these there will generally be superadded peculiar signs pointing out the real seat of the malady, signs almost always to be observed if carefully looked for, and the detection of which is of the utmost importance in the treatment of the disease.

The indications of cure are to avoid or remove the remote causes, to remove the symptoms which especially contribute to aggravate and continue the disease, and to restore the healthy tone of the disordered organs. There is no drug, no class of medicines, no one mode of treatment capable of removing dyspepsia when present, or of preventing its recurrence. This can only be done by a careful study of the exact cause of the disease in every individual case, and the precise seat and nature of the affection. The mode of treatment must be modified in strict accordance with these circumstances; and no mode of treatment will be attended with success of which the appropriate regulation of the diet and exercise does not form an essential part. [Stomach, Diseases of.]

E

E occupies the fifth place in the Hebrew alphabet and those derived from it. The vowels, when arranged according to their physical affinity, would lie in the series *i, e, a, o, u* [ALPHABET], and accordingly the vowel *e* is frequently interchanged with its neighbours *i* and *a*. It is also under special circumstancs occasionally convertible with *o* and *u*.

1. *E* is interchanged with *i*. Thus in Latin the old datives *heri, mani, ruri, musai*, afterwards took the forms *here, mane, rure, musae;* and the words *magis, videris, tristis*, when they appeared without an *s*, were written *mage, videre, triste*. The same interchange appears in the declension of the adjective *is, ea, id*, and the conjugation of the verbs *eo* and *queo*.

2. *E* in Latin often corresponds to *oi* in French. Thus many Latin infinitives in *ere* reappear in French with the termination *oir*, as *habere, dēbere; avoir, devoir*. The Latin past imperfect has the suffix *eba*, which passed through the forms *eva* and *ea* to *oie* and *oi*. Thus from *habebam* were deduced *aveva, avea, avoie*, and lastly *avois* or *avais*. This final *s*, so far as regards the first person, does not appear in the oldest forms of the French language. Other instances of the change of *o* into *oi* may be seen in the Latin adjectives and other words in *ensis* or *esis*, which in French have the suffix *ois, Viennensis, Viennois; mensis, mois*.

3. *E* Latin into *ie* French, as *mel, bene, ped-; miel, bien, pied*.

4. *E* into *a*. This is well marked in the dialects of the Greek *σοφιη*, Ionic; *σοφια*, Doric, &c. Hence the Latins have often an *a* where the common dialect of the Greek had *e*, as *μηχανη, πληγη*; Lat. *machina, plaga*. Both forms often coexist in Latin, as *tristitia-* and *tristitie-*. The *a* is often changed into *e* in Latin, if a prefix is added, particularly if two consonants follow the vowel, as *factus, confectus; pars, expers; castus, incestus; ars, iners*.

5. *E* into *o*. Especially in Greek, when a strong vowel follows, as *λεγω, λογος; νεμω, νομος*. The Latin language prefers an *o*, as *ἐμεω, vomo; πεπτω, coquo; νεος, novus; επι, ob*. This change is particularly common in words beginning with a *w*, or with what was pronounced as a *w*, the Latin *v*. Thus *vester, verto, veto*, were once written *voster, vorto, voto*. Even in our own language *worm* (vermis, Lat.), and *work* (*ἔργον*, Gr.), are now pronounced as if written with an *e*. The Greek even interchanges a long *o* with a long *e* as *πατηρ, ἀπατωρ, εὐπατωρ*; and so too in Latin we have *Anio Aniēnis*.

6. A short *e* often gives place in Latin to a short *u* when followed by one of the liquids *l, n, m*, as in *Siculus*, (Gk. *Σικελος*) *perculsus* (*perc l*), *tabula* (Germ. *tafel*), *decumus* (*decem*), *contumax* (*temno*), *funda* (*σφενδόνη*), *faciundus* (*faciendus*) *euntem*.

EAGLE, CONSTELLATION. [AQUILA.]

EAGLE, Roman Standard. The eagle, as a symbol of empire, is often seen on ancient coins and medals, and on none more frequently than on those of the Ptolemies of Egypt and the Seleucidæ of Syria. As an ensign or standard, borne upon a spear, it was used by the Persians in the time of the younger Cyrus. (Xenoph., 'Anab.' i. 10.)

Pliny ('Hist. Nat.' li. x., c. 4, edit. Hardouin, tom. i., p. 549) says that, till the time of C. Marius, the Romans used five different animals for standards,—the wolf, the minotaur, the horse, the boar, and the eagle,—but that in Marius's second consulate they adopted the eagle as the sole ensign for their legions.

The eagle used by the Romans as a standard was of gold or silver: the latter metal, we are told by Pliny, was most frequently used, as the more glittering, and of course more readily seen. It was borne, like the Persian eagle, on the summit of a spear, and was of the size of a pigeon, with its wings displayed. It sometimes rested upon a cross-bar on the top of the spear, and sometimes upon shields piled up. On the reverses of some of the coins of Augustus and Galba, in second brass, the legionary eagle is represented holding the thunderbolt in its talons. The small size of the eagle often contributed to its concealment, when the legion to which it belonged was defeated. The name of the legion was usually engraved upon it. Tacitus, in his 'Annals,' l. i. 60, relates the finding of the eagle of the nineteenth legion by Germanicus, which had been lost in the massacre of Varus.

Cicero ('Catilin.' i., c. 24) says that Catiline had a silver eagle in his house as his titular divinity, which was also his standard in war.

A Roman eagle in steel, found at Silchester, presumed to have been a legionary eagle, was exhibited to the Society of Antiquaries in 1788 by the then bishop of Carlisle.

The reader will see a great deal of learning displayed upon this and the standard of the cohorts in M. Le Beau's 'Quatorzième Mémoire sur la Legion Romaine; Des Enseignes.' Mem. de l'Académie des Inscript. tom. xxxv., 4to, Par. 1770, pp. 277–308.

The eagle has also been adopted as the standard in the modern French army. It is borne perched at rest on a small base at the top of the banner-staff. Austria bears a double-headed eagle on her banners; and Prussia and Russia have taken the eagle as their national symbol. The United States of America use also the eagle as the national emblem, as well as for the designation of a gold coin of the value of 43*s*. 8*d*., or 10 dollars.

EAGRE. [BORE.]

EAR-RING; a ring hung from a hole, perforated for that purpose through the ear, sometimes set with pendant jewels, pearls, or other precious stones. The word is Anglo-Saxon, *ear-hring*. Ornaments of this sort, large or small, have been worn in almost all countries by women, from the earliest ages; but more rarely by the men. In ancient Egyptian paintings females are represented with large circular ear-rings; but no male figures, except of captives, wear them. In Assyrian sculpture, on the other hand, in which few native female figures occur, all the males of rank from the great king downwards wear large ear-pendants. Botta (plate 161) has figured several of them. Among Oriental nations generally the ear-ring appears always to have been a customary ornament with both sexes. Among the Greeks and Romans it was confined exclusively to the men. Homer makes Hera, when adorning herself so as to appear most fascinating in the eyes of Zeus, place in her ear-tips three-gemmed ear-rings. ('Iliad,' xiv. 182.) Several of the most beautiful Greek female statues have the ears pierced for the reception of ear-rings, which were no doubt of gold or gems. In the Latin of the middle age ear-rings are termed *pendentes*, from the more common form of the ornaments usually attached to the ring itself. Ear-pendants have been occasionally found in British and Saxon barrows in various parts of England.

EAR-TRUMPET, a curved tube employed to aid defective hearing. The rays of sound, proceeding from any source, enter the tube nearly parallel, and its inner surface is so curved that, after one or more reflections, they *converge* upon the membrane of the tympanum, and thus act with increased force.

In early notices of acoustic instruments there is some difficulty in distinguishing such as were intended to be applied to the ear, to assist in collecting sound, from such as were employed in aid of the voice, to enable a speaker to produce articulate sounds in such a manner as to insure their transmission to a considerable distance. [SPEAKING TRUMPET.] To a certain extent, indeed, such instruments may be employed for either purpose, some speaking-trumpets being so formed that, if applied to the ear, they would act as hearing- or ear-trumpets.

The common ear-trumpet is a conical tube of metal, the larger end of which expands like the mouth of a trumpet, while the smaller is so shaped as to enter the ear, and conduct the vibrations of sound collected at the wide end direct to the membrane of the tympanum. The smaller end is frequently curved, in order that it may be applied properly to the ear while the mouth is directed forwards to receive sounds from a speaker in front of the person using it. For the sake of portability, ear-trumpets are frequently made in two, three, or more portions, sliding within one another, somewhat in the same manner as the tubes of an opera-glass.

Various other instruments, of doubtful value, are more or less employed in aid of defective hearing: among these may be mentioned, the *auricle*, a small shell-like instrument, formed of gold, and worn in the ear, so that nothing but the expanded mouth is visible; *ear-cornets*, which are small instruments, made of various shapes and sizes, somewhat resembling a French horn or a musical trumpet in appearance, applied to the ears and held in their place by slender springs; *speaking* or *conversation tubes*, which are flexible elastic tubes of India-rubber and silk, kept open by spiral wire springs, and terminating at one end in an ear-piece, and at the other in an open bell-shaped vessel, which is held before the mouth of the speaker; and *table sonifers*, which consist of a revolving trumpet-shaped cowl mounted on a pedestal, which may be placed upon a table, so as to be turned towards any part of the room where conversation may be going on, and of communicating the sound through a flexible tube to the ear of the deaf person. When flexible tubes are employed for such a purpose, their effect is increased by making them of a tapered or conical shape. An ingenious instrument of the ear-trumpet kind is made in the form of a walking-stick. Another, which is held so as to reflect sound into the ear, is styled the *ear-conch*, and may be termed an auxiliary ear: it is formed of plated metal. The commoner kinds of acoustic instruments are made of tin-plate, japanned; but the better sorts are sometimes formed of silver, or of gong-metal, which is supposed by some to be the best metal for the purpose.

Hebert ('Engineer's and Mechanic's Encyclopædia,' vol. i., p. 463) quotes an opinion from Dr. Morrison, of Aberdeen, that that end of an ear-trumpet which is applied to the ear should not be made so small as to enter the ear, but should be large enough to include the whole of the external ear; for that gentleman, having been deaf for many years, experienced no relief from ordinary ear-trumpets, but found one which he had made of block-tin, on the proposed plan, to succeed.

EARL. The title of count or earl, in Latin *comes*, is the most ancient and widely spread of the subordinate or subject titles. This dignity exists under various names in almost every country in Europe. By the English it is called earl, a name derived to us from the ealderman of the Anglo-Saxons and the eorle of the Danes. By the French it is called *comte ;* by the Spaniards *conde ;* and by the Germans *graf*, under which generic title are included several distinct degrees of rank,—landgraves, or counts of provinces; palsgraves, or counts palatine, of which there are two sorts; markgraves, or counts of marches, or frontiers (whence marchio, or marquess); burghgraves, or counts of cities; counts of the empire; counts of territories; and several others. [Count; Baron.]

After the battle of Hastings, William the Conqueror recompensed his followers with grants of the lands of the Saxon nobles who had fallen in the battle, to be held of himself as strict feuds; and having annexed the feudal title of earl to the counties of the Saxon earls (with whom the title was only official), he granted them to his principal captains.

These earldoms were of three kinds, all of which were by tenure. The first and highest was where the dignity was annexed to the seisin or possession of a whole county, with *jura regalia.* In this case the county became a county palatine, or principality, and the person created earl of it acquired royal jurisdiction and seigniory. In short, a county palatine was a perfect feudal kingdom in itself, but held of a superior lord. The counties of Chester, Pembroke, Hexham, and Lancaster, and the bishopric of Durham, have, at different times, been made counties palatine; but it does not appear that the title of earl palatine was given to the most ancient and distinguished of them—namely, the earl of Chester—before the time of Henry II., surnamed Fitz-Empress, when the title of palatine was probably introduced from the empire. The earls of Chester created barons and held parliaments, and had their justiciaries, chancellors, and barons of their exchequer. This county palatine reverted to the crown in the reign of Henry III. The second kind of earls were those whom the king created earls of a county, with civil and criminal jurisdiction, with a grant of the third part of the profits of the county court, but without giving them actual seisin of the county. The third kind was where the king erected a large tract of land into a county, and granted it with civil and criminal jurisdiction to be held *per servitium unius comitatûs.*

Under the early Norman kings, all earls, as well as barons, held their titles by the tenure of their counties and baronies; and the grant, or even purchase, with the licence of the sovereign of an earldom or a barony, would confer the title on the grantee or purchaser; but with the solitary exception of the earldom of Arundel, earldoms by tenure have long since disappeared, and in late times the title has been conferred by letters patent under the great seal. Earls have now no local jurisdiction, power, or revenue, as a consequence of their title, which is no longer confined to the names of counties or even of places; for several earls, as Earl Spencer, Earl Grey, and others, have chosen their own names instead of local titles.

The coronet of an English earl is of gold surmounted with pearls, which are placed at the extremity of raised points or rays, placed alternately with foliage. The form of their creation, which has latterly been superseded by the creation by letters patent, was by the king's girding on the sword of the intended earl, and placing his cap and coronet on his head and his mantle on his shoulders. The king styles all earls, as well as the other ranks of the higher nobility of peerage, his cousins. An earl is entitled right honourable, and takes precedence next after marquesses, and before all viscounts and barons. When a marquess has an earldom, his eldest son is called earl by courtesy; but notwithstanding this titular rank, he is only a commoner, unless he be summoned to the House of Lords by such title. So the eldest sons of dukes are called earls where their fathers have an earldom but no marquisate, as the Duke of Norfolk, &c.

The number of English earls in the House of Lords is at present (1859) 110. Of Scotch earls there are 42, and of Irish earls 65, of whom many have seats in the House of Lords in consequence of possessing a British peerage also.

EARL MARSHAL OF ENGLAND, one of the great officers of state, who marshals and orders all great ceremonials, takes cognisance of all matters relating to honour, arms, and pedigree, and directs the proclamation of peace and war. The *curia militaris*, or court of chivalry, was formerly under his jurisdiction, and he is still the head of the heralds' office, or college of arms. Till the reign of Richard II., the possessors of this office were styled simply marshals of England; the title of earl marshal was bestowed by that king, in 1386, on Thomas Lord Mowbray, Earl of Nottingham. The office is now hereditary in the family of Howard, and is enjoyed by the Duke of Norfolk.

EARTH (Astronomy). In the language of astronomers, the earth is rarely treated as a planet. All the phenomena connected with its motion are seen in the apparent motion of the Sun, to which article we therefore refer.

EARTH, CONTROVERSY ON THE MOTION OF THE. [Motion of the Earth.]

EARTH, FIGURE OF THE. [Geodesy.]

EARTH, MEAN DENSITY OF THE. The quantity of matter which the earth contains must ultimately be our only guide to that of any other planet. The relative masses of two planets can be found by calculation of the effects which they produce upon any third body; but the mass of a planet with reference to any given substance, as water, cannot be directly determined upon any instance except our own earth. Perhaps a problem could hardly be proposed which would seem more impracticable to the ordinary reader than that of determining the mean density of the earth. It amounts to asking this:—If it were required to substitute for the earth a solid globe of the same size, *but of uniform material*, in such a manner that the absolute weight of bodies on its surface should remain the same, and the attraction of the whole on other planets remain the same—what must the material be?

Of necessity this question was started by Newton, whose system was the first in which it became of much interest. Having no means of submitting it to experiment, he made one of those sagacious guesses which, had they been collected and preserved, would alone have kept his memory alive. "Unde cum terra communis suprema quasi duplo gravior sit quam aqua, et paulo inferius in fodinis quasi triplo vel quadruplo aut etiam quintuplo gravior reperiatur: verisimile est quod copia materiæ totius in terrâ quasi quintuplo vel sextuplo major sit quam si tota ex aquâ constaret." ('Principia,' iii. 10.) That is, he judged the earth to be between five and six times as massive as the same bulk of water; which is the truth.

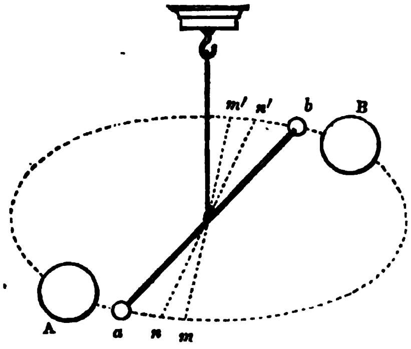
The relative masses of two planets are determined by the observation of their effects upon a third. Two preliminaries are required: first, the great assumption of the theory of gravitation, that any two particles of matter must attract one another with forces which at different distances are directly as their masses, and inversely as the squares of those distances; secondly, the mechanical consequence of this law of action, namely, that two spheres, having their centres at any given distance, attract one another in the same manner as if each were collected in its centre. Without describing the mode of arriving at such a result from observation, suppose it is ascertained that two planets, A and B, whose distances from a third are as 4 to 3, attract that third with forces which are as 7 to 2. If both planets be brought to the distance 1 from the third, the attraction of the first will be made (4 × 4, or) 16 times as great as before, and that of the second (3 × 3, or) 9 times. Consequently, the new attractions will be as 7 × 16 to 2 × 9, or as 112 to 18. But at equal distances the attractions are in the proportion of the masses; therefore these masses are as 112 to 18. Now suppose the radii of the planets to be as 3 to 2; then their solidities are as 27 to 8, and if the densities (mean) are δ and δ', the masses are as 27δ to $8\delta'$. Therefore $27\delta : 8\delta' :: 112 : 18$, or $\delta : \delta' :: 112 \times 8 : 18 \times 27 :: 896 : 486$. If then the mean density of either planet be known, that of the other can be found.

The principle of the preceding process exists in every attempt which has been made to find the mean density of the earth. The earth itself is made one of the planets; some known substance, a mountain or a ball of lead, is made the other planet. The attracted body is not a planet, but a pendulum or a plumb-line, and the effect of the mountain or ball of lead upon the plumb-line is measured, that of the earth being either measured or previously known. The actual attraction of the mountain or ball of lead being thus determined, its effect as it would be if placed at the centre of the earth can be calculated; which effect is to the effect of the earth as the mass of the mountain or ball of lead to that of the whole earth. The result of this process, as usual, is condensed into a formula, in which the mode of making the steps is lost sight of: but the above is not the less the manner in which the experiment must be explained.

The hint given by Bouguer, the experiment of Maskelyne, and those of Cavendish and Zach, have been briefly described in Attraction. Since their time two repetitions of Cavendish's experiment have been made: the first, by Dr. Reich, of Freyberg, of which an account was published in 1838; the second, by Mr. Baily, at the desire of the Astronomical Society, and at the expense of the government. ('Mem. Ast. Soc.,' vol. xiv.) The former obtained the same result as Cavendish, but the experiments were few in number; the latter obtained a result slightly differing from that of Cavendish, but in so many different ways and by so large a number of experiments, that it is impossible to doubt the superior correctness of the conclusion. We shall give such a slight general account of this process (which is substantially that of Cavendish) as our limits will admit, referring to the volume already cited for more detail: very few experiments have been either so well performed or so satisfactorily described.

A torsion pendulum (76 inches long) was provided, moving on a single or double metal wire, or on a double silk line, the mode of suspension being varied from time to time. At each end was suspended a metal or other ball; and these balls (*a* and *b*) were the principal attracted substances. The whole torsion-rod with the suspension was inclosed in a case, with a glass at one end. Large leaden balls (A and B) of about twelve inches diameter (the attraction of which on the torsion pendulum is the quantity to be measured in the experiment) were made to travel on a frame in such manner that they could quickly be brought up laterally on opposite sides of the balls, as in the diagram. We must leave out the whole account of the precautions against electricity or radiation, the manner of noting the actual position of the pendulum, &c., and confine ourselves to the principle of the experiment.

When a torsion pendulum, such as that described, is left to itself,



it never is reduced to absolute rest. The instrument is so delicate that it is in continual oscillation to a small extent, and its position of rest, say mm' is found by taking the mean of the extreme positions on one side and the other. Even this mean position is continually shifting its direction, so that it cannot be permitted to take a series of observations and make use of them all in determining one mean place. The mode of finding the point of rest, that is of deducing it from observing the extremes of the vibration, is described in the work cited. As soon as the line of rest of the undisturbed pendulum is ascertained, and the large balls are brought into the attracting positions at A and B, on continuing the observation an immediate alteration of the line of rest is seen towards the large balls; say that it becomes nn'. Then the position of equilibrium of the pendulum is altered by the angle nom, in consequence of the approach of the balls.* The precautions taken are abundantly sufficient to assure us that the alteration is no consequence of heat, electricity, magnetism, or any of the variable accidents of matter; there is nothing to which it can be referred except that attraction which, when the earth is the agent, we know under the name of weight, and the assumption of which, as a universal property of matter, led Newton to his explanation of the planetary motions. Many of those who were content to receive Newton's hypothesis to this extent, that the planets attract each other, were staggered by the idea that every particle in the universe attracts every other. Such objectors might have here received conviction from the evidence of their own senses, which would have rendered obvious not only the attraction of the balls upon each other, but its transmission through the wood, flannel, and gilding, which it was found necessary ultimately to interpose between the attracting substances and the torsion-rod in order to destroy the effects of radiant heat.

Two observations are necessary, that of the time of oscillation of the pendulum, and that of the displacement of the line of rest which the approach of the larger balls produces. The first observation, the time, enables the observer to deduce the force of torsion, or the quantity of pressure required to produce any given displacement. And in this particular it was found that the pendulum altered its character from one quarter of an hour to another; showing that the instrument was so delicate, that circumstances of which no explanation can be given were continually altering its character. The consequence was, that at every new trial, both the time and displacement had to be scrupulously observed together, in order that to each displacement produced the proper producing attraction might be applied. The complete formula for calculating the mean density of the earth, implies,—1. The calculation of the character of the pendulum, or the amount of attraction necessary to alter its line of rest by a given quantity; 2. The determination of the attraction actually employed, namely, that of the larger balls, by means of the displacement actually observed; 3. The determination of the attraction which the larger ball would exert, if it had been at the centre of the earth, instead of at the distance † employed; 4. The number of times the whole earth would contain such a leaden ball, and its easy consequence, namely, the number of times the whole earth would contain a similar bulk of water; 5. All the necessary corrections for the attraction of the other parts of the apparatus upon the torsion pendulum.

The larger masses were leaden balls, but the smaller balls attached to the torsion pendulum were changed from time to time, and different substances were used. The following table of results will be more interesting than any description we could give in the same space. It shows the result of the experiments made after the effects of radiation were removed ‡ by additional precautions. The first column is the number of experiments made, with the small balls and mode of suspension described in the third; the second contains the mean density of the earth as deduced from that set of experiments; the third describes the small balls and mode of suspension employed; the numerals, which are fractions of an inch, representing the diameter of the suspension wire, when single, and the distance of the wires when double or *bifilar*:—

No. of Experiments.	Density.	Balls and Suspension.		
8	6·154	brass rod alone	bifilar iron	·177
20	5·993	,,	,,	·415
28	5·925	,,	,,	·367
42	5·847	2-inch ivory	,,	·367
79	5·839	,,	bifilar silk	·367
51	5·799	2-inch glass	,,	·177
20	5·787	2-inch ivory	single copper	·0178
20	5·784	2-inch glass	bifilar silk	·415
87	5·774	,,	,,	·367
20	5·766	2-inch ivory	,,	·415
20	5·738	2-inch zinc	single copper	·0178
40	5·725	,,	bifilar silk	·367
102	5·719	,,	,,	·177
46	5·717	2½-inch brass	,,	·367
170	5·716	2-inch glass	bifilar iron	·415
32	5·688	2-inch lead	bifilar brass	·415
43	5·679	1½-inch platina	bifilar silk	·177
74	5·674	2-inch lead	single copper	·0178
142	5·673	,,	bifilar iron	·415
111	5·669	,,	bifilar silk	·177
20	5·668	2-inch zinc	bifilar iron	·415
104	5·658	2½-inch lead	,,	·415
84	5·652	2-inch lead	bifilar silk	·415
44	5·649	2½-inch lead	,,	·367
27	5·647	,,	single copper	·0178
46	5·644	1½-inch platina	bifilar silk	·367
20	5·641	2-inch zinc	,,	·415
120	5·637	2-inch ivory	bifilar iron	·415
54	5·635	2½-inch lead	bifilar silk	·415
20	5·606	2-inch lead	bifilar iron	·367
92	5·599	2½-inch brass	single copper	·0219
20	5·586	2½-inch lead	bifilar iron	·367
23	5·582	2-inch lead	bifilar silk	·177
86	5·559	1½ inch platina	single copper	·0219
30	5·549	2½-inch lead	,,	·0219
50	5·533	,,	bifilar brass	·380
88	5·525	2-inch-lead	single copper	·0219
20	5·507	2-inch zinc	,,	·0219
50	5·500	2½-inch lead	bifilar silk	·380

The results of individual experiments vary considerably, but it is important to observe that there is nothing which indicates that different kinds of matter attract each other according * to different laws. If the large ball of lead exerted different attractions upon particles of brass and ivory of the same weight, the effect would be to give the whole earth one mean density or another, according as the smaller ball is of brass or ivory. Now it is true that the experiments give all manner of results from 5·500 to 6·154, but on examining the results, there appears no evidence whatever of the larger balls attracting the different smaller ones differently. If such were the case, undoubtedly the mean densities obtained from different substances would be different; but though such is the case in the preceding list, and even though it would seem that the lighter balls give the larger densities, yet there is every reason to suppose that the effect is to be attributed to the alteration of the pendulum. Thus it will be seen that there is not so much difference between the results of 2-inch ivory and lead balls suspended in the same way by a single copper wire, as there is between the results of 2-inch lead balls suspended by bifilar iron wires, and the same suspended by bifilar brass wires, and also that ivory balls differently suspended give results which have differences as great as any. The mode of suspension and the effect of merely increasing the weight of the smaller balls, appear much to exceed that of applying different substances; but not according to any law. In fact, the differences are altogether of that character to which the term discordance is applied; following no settled rule, and exhibiting every appearance of as often affecting the truth by a positive as by a negative error. The first three sets, in which a brass rod alone is used, were rather a defiance to the apparatus to fail if it could, than seriously intended to help the result. Almost all the experiments were made with a light wooden torsion-rod, and comparatively heavy balls appended. The trying a brass rod by itself, that is, the attempt at obtaining a mean density by noting the attraction of the larger balls upon the torsion-rod only, was the introduction of an extreme case, to increase confidence in the more ordinary experiments.

The mean of the whole is 5·6747, and, rejecting the experiments of which the character would be *à priori* most doubtful (though it is not certain they ought to be rejected) it is reduced to 5·6604. From the experiments, by the usual rules of the theory of probabilities it is an even chance that the error of this result is within ·04. Cavendish's result was 5·48.

---

* In making the experiment the effect was usually doubled by placing the large balls first on one side of the smaller ones, and then on the other, and noting the whole of the double displacement.

† This distance of course was accurately measured.

‡ An enormous mass of experiments was made and rejected in the course of the attempts to remove singular discordances, of which no explanation could be given. The mean result of these would not have differed much from those of the more correct sets, but would, of course, have been less satisfactory. The removal of the discordances was due to the suggestion of Professor Forbes, of Edinburgh, who continued to believe they might arise from radiation long after others thought the precautions then already taken must have been sufficient to remove that source of disturbance.

* That it is not the case, is also established without a doubt by pendulum experiments.

Besides the confirmation of some of the most material points of the theory of gravitation which results from this experiment, it furnishes a presumption of the strongest kind that the earth is solid to the centre, and not, as many have supposed in every age, a hollow shell. The mean density 5⅔ is very much greater than that of the substances which abound at the surface. All common rocks are under 3, and nothing under the ores of the heavier metals comes up to 5⅔. The earth is as massive as if it were all composed of silver-oré, from the centre to the circumference, so that there must be an increase of density towards the centre. If those who think the earth to be a shell were to presume that its solidity ceased at five hundred miles below the surface, they would then be compelled to give to the terrestrial matter, one part with another, a density greater than that of mercury, in order that the whole shell, the hollow part included, might have the mean density which is found by this experiment.

Recently, Mr. Airy, the present Astronomer Royal, has determined the mean density of the earth by means of observations of the rate of oscillation of a pendulum made at the top and bottom of a coal-mine in the county of Durham. As early as the year 1826 he endeavoured, in conjunction with Dr. Whewell and the late Mr. Sheepshanks, to effect the same object by means of pendulum experiments in the Dolcoath mine in Cornwall, but the project was frustrated by local accidents; and a similar attempt in 1828 proved equally fruitless. The principal obstacle to the success of the experiments on those occasions consisted in the difficulty of comparing the clocks at the top and bottom of the mine. In more recent times the application of galvanic electricity to the transmission of signals suggested to Mr. Airy an easy method of conquering this impediment. He accordingly resolved to repeat the experiment, and chose for that purpose the Harton colliery, near South Shields, the bottom of which is no less than 1260 feet beneath the earth's surface. The application of pendulum experiments made at the earth's surface, and at some distance beneath it, to the determination of the mean density of the earth, rests on two principles of attraction, both of which were originally established by Newton. The first is, that the attraction exercised upon an external particle by a sphere of uniform density, or one consisting of concentric strata of different densities, but of uniform density throughout each stratum, is the same as if all the matter of the sphere were collected at the centre. The second is, that a hollow spherical shell of matter exercises no effective attraction on a particle placed anywhere within it. Now, in the case of experiments made with a pendulum at the top and bottom of a coal-mine, the pendulum is acted upon in the former instance by a force equivalent to the attraction which the whole quantity of matter contained in the earth would exert if it were collected at the centre; in the latter instance the quantity of attracting matter is less than in the former by the spherical shell, whose thickness is equal to the distance between the top and bottom of the mine, but the distance of the particle from the centre of attraction is less. It is clear then, that experiments founded on the principles to which we have just alluded, enable us to weigh the whole mass of the earth against an exterior shell of a given thickness; and therefore if the density of the shell (or at any rate the density of the parts which are nearest the mouth of the mine, and on which the attraction exerted by the shell upon the pendulum mainly depends), be ascertained by observation, we shall hence readily deduce the value of the mean density of the earth. Mr. Airy's experiments on the rate of oscillation of the pendulum at the top and bottom of the Harton colliery were made in the summer of 1854. Several English observatories co-operated in their execution by furnishing assistant observers. The Electric Telegraph Company supplied the means of establishing simultaneous galvanic signals between the upper and lower stations. The observations consisted of 104 hours of incessant observations of one pendulum A, above, and another pendulum B, below; then of 104 hours with B above, and A below; then of 60 hours with A above and B below: then of 60 with B above and A below. It appeared from these experiments that the lower pendulum was accelerated 2·25″ per day, or in other words, that the force of gravity was more intense at the lower station than at the upper by $\frac{1}{19190}$th part. The final conclusion which Mr. Airy deduced from these experiments was, that the mean density of the earth is 6·623, the mean density of water being represented by unity. This result, it will be seen, is considerably higher than any value of the same element hitherto found.

The most recent operations for determining the mean density of the earth are due to Colonel James, Superintendent of the Ordnance Survey, who, in 1855, caused a series of celestial observations to be made to the north and south of Arthur's Seat, near Edinburgh, for the purpose of ascertaining the amount of deflection caused by the attraction of the mountain. The resulting value of the mean density was found to be 5·316, with a probable error of 0·054. Colonel James purposes, as soon as the details of the survey of Ben Nevis have been completed, to obtain a new solution of the important problem of the mean density of the earth by determining the amount of deflection caused by the attraction of that mountain, which is the highest in the British Isles, and appears to be in other respects well adapted for the object in view.

The reader may consult the following recent works on this subject: 'Experiments with the Torsion-rod, for determining the mean density of the Earth,' by Francis Baily, Esq. ('Mem. Ast. Soc.,' vol. xiv.); 'Account of Pendulum Experiments undertaken in the Harton Colliery, for the purpose of determining the mean density of the Earth' (with a Supplement), by G. B. Airy, Esq. ('Phil. Trans.' 1856, vol. cxlvi.); 'On the deflection of the plumb-line at Arthur's Seat, and the mean specific gravity of the Earth,' by Capt. Clarke,* R.E. ('Phil. Trans.' 1856, vol. cxlvi.)

EARTHENWARE. The art of moulding earthen vessels for domestic use appears to have been practised in the earliest ages, and among the rudest nations. It is at once the most ancient and the most widely diffused of the arts. In newly-discovered countries it has been found that the use of earthen vessels is familiar among people otherwise little acquainted with the arts of civilised life. Vases have been discovered in the ruins of temples and palatial buildings, constructed by the Aztecs, and other aboriginal tribes of central America; and there is strong evidence for believing that these vessels were the manufacture of the country in which they were found. The potter's wheel is represented in the sculpture and painting of ancient Egypt; frequent reference is made to it in the scriptures of the Old Testament; it must have been in use from a very remote date in ancient Assyria, China, and Japan. In Greece, Rome, and Etruria the potter's art was cultivated with the greatest diligence from the earliest and rudest period of their respective histories, to that of their highest prosperity and refinement. The art indeed arrived at a point of great advancement among the oldest of these nations. In ancient Egypt were made vases and other articles of very elegant forms, as well as common ware for domestic use. From the analyses made at the laboratory of the Museum of Practical Geology, it appears that the pastes or bodies used in making Egyptian earthenware, as seems indeed to have been the case with most ancient pottery, were merely "the natural clays selected for their fitness to the purposes for which they were intended." Glazes or enamels were used by the Egyptians for covering small figures made of a frit of sand, but it is believed that it was not till the later periods of their history that they acquired the art of applying vitreous glazes to their earthenware proper. The Assyrian and Babylonian pottery, as Mr. Birch remarks in his 'History of Ancient Pottery,' "although it bears a general resemblance in shape, form, and use, to that of Egypt, has certain specific differences. As a general rule it may be stated to be firmer in its paste, brighter in its colour, employed in thinner masses, and for purposes not known in Egypt." The Assyrians were, from a very early period, fully acquainted with the use of siliceous and metallic glazes or enamels, and produced them of brilliant colours. Very little of their earthenware has, however, been recovered.

In the hands of the Greeks, vessels of earthenware assumed forms of the most perfect grace and symmetry; and much additional interest was imparted to them for future ages by the practice of painting on them designs which serve now as the truest reflex of Greek painting of the several periods, and afford an almost limitless store of illustration of Greek customs, mythology, &c. The earliest remaining examples of Greek fictile vases are of a pale yellow clay, and have the designs rudely painted of a dark reddish brown. Later, the figures were painted in a black glaze on a pale or red ground. But in the best period of Greek art the earthenware was formed of a reddish substance. which was glazed black; the figures of the design being left of the natural red of the ground. The shapes are of almost infinite variety, but almost invariably marked by the most beautiful simplicity of outline. The pottery of Athens was the most celebrated in Greece, and Athenian vases were offered as prizes in the public games. That of Samos was famous in the days of Homer. With the decline of Greece, all its arts gradually declined, and eventually perished together. Ancient Greek vases are among the most esteemed objects in museums of antiquities: during the last century in particular, extraordinary prices were given for fine specimens: a famous vase, containing a representation of the last night of Troy, was purchased for the Museo Borbonico for 1500*l.* But owing to the vast numbers of them, and of Etruscan vases, which are essentially similar in character, which have been found, the prices have fallen considerably, though very high prices are still readily given for superior examples. [VASES.]

Roman pottery is, in an artistic point of view, of far less value than that of Greece, but as a manufacture much of it is of a very superior quality. The use of earthenware for domestic purposes was almost universal with the Roman people, and wherever they settled they appear to have carried the manufacture with them; not only Roman pottery, but traces of kilns for the firing of the ware having been found in most of the countries in which were Roman settlements. The ware itself is usually of a bright red colour, given to it by the introduction of a peroxide of iron into the paste, and it bears a brilliant glaze. M. Brongniart calls particular attention to the perfection of workmanship exhibited in this ware, in the making of which he says most of the processes now in use appear to have been employed.

With the fall of the Roman empire the arts for a time perished also.

---

* Communicated by Colonel James, under whose superintendence the whole operation was conducted.

The ceramic art appears to have lingered longest in the Lower Eastern empire, and from thence to have been acquired by the civilised Arab races who played so important a part in the history of the 9th and following centuries. The Moors of Spain were especially proficients in this art, as is shown, not merely in the beautiful tiles of enamelled earthenware with which they decorated the Alhambra and other of their great buildings, but in vases and other earthenware articles still preserved in public museums. To them, in fact, is due the preservation of the art, and the direction it took upon its revival in Spain and Italy in the early part of the 15th century. The Moorish works continued to flourish till the expulsion of that people from Spain; they were continued, though with little comparative success, by the Spaniards.

The famous Italian Majolica ware, now in such repute with collectors, owes its name to Majorca, the largest of the Balearic Islands, where, whilst it was held by the Moors, was a large manufacture of earthenware, or an emporium for its sale. The island was taken by the Pisans in 1115, and immense spoils were carried by the victors to Pisa; but whether it was from Majorca that the art itself, as well as the name, was derived, is not certain. The earliest so-called majolica ware of the Italians is, however, beyond doubt an imitation of the Moorish ware. But it was not till the 14th century that the Italian pottery began to assume a decorative character, though, according to Pessari ('Istoria delle Pitture in Majolica'), vessels made of red clay at Pesaro, were covered with an opaque coloured, and also a thick white, glaze in the previous century. The so-called mezza-majolica, with patterns of a Moorish character, surrounding portraits, figures of saints, &c., seems to have been first made at Pesaro, where, from about the middle of the 15th century it was produced of so superior a quality as to be regarded as sufficiently valuable to offer as presents to sovereign princes and persons of distinction. The manufacture spread thence into other parts of Italy, and was zealously encouraged by the several princes. Urbino, Gubbio, Castel Durante, and other cities became especially famous for their majolica. At Urbino, artists of great ability were called into requisition to paint the designs upon the vessels; and from the designs of Raffaelle being very frequently copied, and in later years it being reported that Raffaelle himself sometimes painted upon earthenware, the ware itself was long commonly known in this country as Raffaelle ware. It is now, however, generally admitted that there is no ground for supposing that the great painter ever so employed his pencil, the painting being generally executed by artists who devoted themselves to this particular occupation. Most of the majolica ware bears a general resemblance, but that of Gubbio is distinguished by a brilliant lustre, produced by the use of a stanniferous glaze, for the production of which an artist known as Maestro Giorgio, but whose real name was Giorgio Andreoli, who flourished during 1485–1532, was particularly famous. The coloured relievi of Luca della Robbia (1400-81) was formed of earthenware, or glazed terra-cotta, but it hardly belongs to our present subject, though his labours doubtless contributed greatly to the improvement of Italian earthenware generally.

The fine Majolica—or that which owes its celebrity to the beauty of its designs—is considered to have been produced in its greatest perfection from 1540 to 1568. It then began to decline, and the art of making it was finally lost by the early part of the 18th century; majolica having come to be regarded as barbarous, as Oriental porcelain became the dominant fashion. In our own day we have seen the collecting of majolica ware become a passion; and specimens of it, which but a few years ago would hardly have received a second glance, are now regarded as among the most precious ornaments of the museum and the palace. Plates of fine majolica, and of the lustrous ware of Maestro Giorgio, the size of an ordinary dinner plate, have been sold by public auction for as much as 150*l.* each; and large dishes and other articles of less ordinary character, for a much greater sum. A majolica plate, 9½ inches in diameter, now in the South Kensington Museum, will well illustrate the rapid growth of the majolica mania. At the Stowe sale (1848) it was purchased by a London dealer in these "curiosities," for 4*l.* The following year he sold it to Mr. Bernal for 5*l.* At the sale of that gentleman's collection in 1855, it was purchased for the South Kensington Museum for 120*l.* The plate is interesting chiefly as containing a representation of a majolica painter at work. Of late years the manufacture of spurious majolica ware, as well as spurious Greek and Etruscan vases, has been brought to such perfection by those inimitable and most industrious forgers of every object of ancient art, the Italians, that even skilful archæologists and collectors find it extremely difficult to detect the imposture.

In France, earthenware was made as early as the 12th century; and that of Beauvais had become celebrated in the 14th; but the impulse to the manufacture of really decorative ware appears to have been imparted by the establishment of a pottery at Nevers, and the introduction of Italian majolica workers by Catherine de' Medici. The most characteristic old French earthenware, however, is that of Bernard Palissy (1510–89), of which, the most remarkable has raised figures of fishes, reptiles, fruit, and other natural objects, imitated in their actual colours; and which, in pecuniary value, rivals majolica. In Nuremberg and some other parts of Germany, and in Holland, the manufacture of enamelled ornamental earthenware was pursued with great success during the 16th and 17th centuries. Holland earthenware, under the name of delft, was, prior to the growth of the Staffordshire factories, that ordinarily used in this country. The earthenware drinking jugs of quaint shapes, but some far from inelegant, are familiar from their constant occurrence in Dutch pictures.

The Britons must have understood the potter's art before the Roman occupation, since urns of earthenware have been found in barrows in different parts of the kingdom. Vestiges of considerable Roman potteries have been discovered in many parts of this island, particularly in Staffordshire; at Castor, Northamptonshire; at Lincoln; in the New Forest; and on the site of a former island in the Queen's Channel near Margate. Probably rude pottery continued to be made in England. Decorative tiles for ecclesiastical purposes were wrought during the Norman dynasty; and perhaps, in one form or other, the making of earthenware never ceased to be practised here. In the 16th and 17th centuries, it is evident, from the many specimens of drinking vessels, dishes, &c., in private collections, that a good deal of attention was given to the making of ornamental earthenware, the principal seats of the manufacture being Lambeth, Burslem, and Liverpool. But, as already said, till far into the 18th century, England was chiefly indebted for its ordinary domestic earthenware to Holland, and for superior kinds to Germany and France. English earthenware and porcelain are now, however, not only brought into general use in this country, nearly to the exclusion of foreign goods, but earthenware is also largely exported to almost every part of the known world, and even to those countries where the art was previously prosecuted. M. Faujas de Saint Fond observes on this subject: "Its excellent workmanship, its solidity, the advantage which it possesses of sustaining the action of fire, its fine glaze impenetrable to acids, the beauty and convenience of its form, and the cheapness of its price, have given rise to a commerce so active and so universal, that in travelling from Paris to Petersburg, from Amsterdam to the furthest part of Sweden, and from Dunkirk to the extremity of the south of France, one is served at every inn upon English ware. Spain, Portugal, and Italy are supplied with it; and vessels are loaded with it for the East Indies, the West Indies, and the continent of America." Since this intelligent French traveller wrote, the distribution of English earthenware all over the world has vastly increased. England is mainly indebted to Josiah Wedgwood for the extraordinary improvement and rapid extension of this branch of industry. Wedgwood's success was not the result of any fortunate discovery accidentally made, but was due to patient investigation and unremitting efforts. He called upon a higher class of men than had usually been employed in this manufacture to assist in his labours; and in prosecuting his experiments he was guided by sound scientific principles. The early and signal success which crowned his first exertions only served as an additional motive for continuing his pursuit. One of the principal inventions of Wedgwood was his *table ware*, known afterwards as *queen's ware*, in consequence of the patronage of Queen Charlotte, who commanded it to be thus designated. It is a dense and durable substance, covered with a brilliant glaze, and capable of bearing uninjured sudden alternations of heat and cold. From its first introduction, it was manufactured at so cheap a rate as to render it an article within the reach of all. Soon afterwards, embellishments were introduced, which added only a little to the cost of the article; first, a coloured edge or painted border was added to the queen's ware; and, lastly, printed patterns covering the whole surface. Wedgwood's more beautiful inventions were—a *terra cotta*, which could be made to resemble porphyry, granite, Egyptian pebble, and other beautiful stones of the siliceous or crystalline kind: a black porcelainous biscuit [BISCUIT] very much resembling basalt in its properties, and therefore called *basalt;* a white and a cane-coloured biscuit, both smooth, and of a wax-like appearance; and another white biscuit, distinguished as *jasper*, having in general all the properties of the basalts, with a very important addition, namely, the capability of receiving through its whole substance, from the admixture of metallic oxides, the same colours as those oxides communicate to glass or enamel in fusion. This peculiar property of the jasper-ware renders it applicable to the production of cameos and all objects required to be shown in bas-relief; as the ground can be made of any colour, while the raised figures are of the purest white. Mr. Wedgwood likewise invented a *porcelain biscuit*, nearly as hard as agate, which will resist the action of all corrosive substances, and is consequently peculiarly well adapted for mortars in the chemist's laboratory.

We have only been able to treat very cursorily the history of earthenware; those who may desire further information respecting it will find ample particulars in Alexandre Brongniart's 'Traité des Arts Céramiques, ou des Potteries considerées dans leur Histoire, leur Pratique, et leur Théorie,' Paris, 1844; 'A History of Ancient Pottery and Porcelain: Egyptian, Asiatic, Greek, Roman, Etruscan, and Celtic,' by Samuel Birch, London, 1857; and 'A History of Pottery and Porcelain, Mediæval and Modern,' by Joseph Marryat, London, 1857, which, together, cover the entire field of inquiry, and supply, with their references, materials for extending research as far as may be desired. It may not be out of place, however, to add that the public museums of the metropolis now afford the student means of obtaining that actual knowledge of the products of the art which books alone cannot possibly supply. The British Museum contains many specimens of the pottery of ancient Egypt, Assyria, and Babylonia. Its collections of Greek and Etruscan vases occupy two spacious rooms. Of Roman pottery, including that found in Great Britain, it contains numerous examples. It has also many specimens of Celtic and ancient British pottery; and it has a varied and rich collection of the Hispano-Moorish, Majolica, and Delft earthenware spoken of above. But in these latter classes the South Kensington Museum is still richer. The specimens of majolica in the British Museum number somewhat under 200, in the South Kensington Museum they are about 500. In this latter museum the majolica is arranged according to the towns in which it was produced. Both museums, however, contain many very fine and characteristic examples; and South Kensington is rich in early French and English ware. Finally, at the Museum of Practical Geology in Jermyn Street, are characteristic, though not numerous, examples of the potter's art of almost every period from the most ancient down to the present time; together with specimens of the different kinds of earth, the glazes and the enamels employed in their production. An hour or two spent in examining these collections will give clearer notions on the history of the ceramic art and the character of its productions than can possibly be obtained from mere descriptions.

Although earthenware may be considered as a general term applicable to all utensils composed of earthen materials, it is now usual to distinguish such utensils more particularly into three different kinds; namely, pottery, earthenware, and porcelain. Under the first of these terms are classed the brown stone-ware made into jugs, &c., the red pans and pots in common use, porous vessels, &c. [POTTERY.] Porcelain is distinguished from earthenware as being a semi-vitrified compound, in which one portion remains infusible at the greatest heat to which it can be exposed; while the other portion vitrifies at a certain heat, and thus intimately combines with and envelopes the infusible part, producing a smooth, compact, shining, and semi-transparent substance, well known as the characteristic of true porcelain. [PORCELAIN.] The third-class, intermediate between these two, is the subject of the present article.

The principal ingredients employed in the composition of all kinds of earthenware and porcelain are clay and flint. The nature of the clay used in the manufacture is of great importance, and so also is the combining of it with a due proportion of flint. The clay principally used in the Staffordshire potteries is obtained from Dorsetshire and Devonshire, and is distinguished into the qualities of *brown*, *blue*, *black*, and *cracking* clays. All these clays are of good working quality, and burn extremely white, being free from any impregnation of iron; the blue clay is considered the best. About 70,000 tons of Dorsetshire clay is exported yearly from Poole, for the use of the Staffordshire manufacturers. Another description of clay, superior to any of these, and found in Cornwall, is commonly denominated *China* clay, because similar in its properties to the porcelain earth of China. This Cornwall clay is so indispensable in porcelain, and so valuable in the finer kinds of earthenware, that it may be well to describe here the processes of its preparation, from a paper recently drawn up by Mr. Stokes, of St. Austell.

The disintegrated granites of Cornwall, which are commercially know as *China stone* and *China clay*, were first used as ingredients in potter's clay about 1768, through the instrumentality of Mr. Cookworthy of Plymouth; and the consumption became greatly increased when it was found that, if fused, the disintegrated granite would form a suitable glaze for articles made of the clay. This was the China clay, or kaolin. The China stone was not brought into use till 1802, when a Cornish bed began to be worked, comprising felspar, silica, and mica, without any iron or manganese; if granite contains talc, hornblende, or diallage, it is unfitted to form China stone. The good China stone is found principally in proximity with fissured granitic rocks, near St. Austell. It is believed that the granite has been brought to the states of China stone and China clay by a variety of causes—the alternation of hot and cold weather; the solvent power of rain water; and the action of chemical agents in the air and water. The chief hill or district of the China stone is divided off into several portions, leased by different individuals or companies. The stone is sufficiently hard to need quarrying by gunpowder and the pick; it is raised from the pits, and transferred to waggons near the pits' mouths. It undergoes no preparation, but is at once shipped to Staffordshire, where the potters are left to deal with it as they please. The price is greatly increased by the cost of land carriage to the nearest port of shipment; but now (1859) that the Cornwall Railway is opened, there is a prospect of increased facility of transport. It is supposed that there are about a million tons of China stone in the St. Austell beds. The China stone in its present state consists of a mixture of quartz, felspar, and mica, blended so as to form a homogeneous mass, much resembling granite, but with a texture less compact. Chemically it is a nearly-pure double silicate of potash and alumina, which, when fused, forms a pearl-white translucent mass, firm and resonant; it has an opaque body of nearly perfect kaolin, surrounded by and diffused through a glaze of silicic acid, to which its translucency is due. The China clay or kaolin is more abundant than the China stone, and is shipped to Staffordshire to the extent of about 100,000 tons per annum. It is not, like China stone, confined to one or two localities, but is distributed in many parts of the county. It is found intermixed with quartz and mica in most of the valleys contiguous to hills of disintegrating granite. The substance presents itself as an amorphous whitish-blue powder often lying contiguous to formations of granite, killas, clay-slate, and grauwacke. The clay assimilates in quality to the granite from which it has been derived; if the felspar be very white, the clay is white; if there is much mica, the clay becomes strong and tenacious. The clay is worked and filtered in large recesses formed in the surface of the ground; allowed to remain till solid; cut into square blocks; conveyed to a drying-yard; and there allowed to remain until white and quite dry. There being some difficulty in drying the clay in wet localities, Mr. Stokes has invented a method of expediting the process; it consists in the use of a number of perforated cylinders, having on them shelves similarly perforated, or made of wire-gauze; these cylinders are kept rotating two hundred times a minute, by four attached multiplying wheels, worked by wind, water, or steam; they have several perpendicular screw-like arms, on each of which are a number of transverse shelves for the carriage of the clay; the rapid action of the wheel causes currents of air to be thrown upon the clay, which soon becomes dry. The blocks are kept in a place where cool dry air can reach them, until shipped to the Potteries. The China clay varies in price from 20*s.* to 50*s.* per ton, according to its purity, hardness, whiteness, and freedom from shrinkage when calcined. Not less than 7000 men, women, and children, are employed in Cornwall in collecting and preparing the China stone and clay.

We will now suppose the requisite ingredients to have reached the pottery establishments in Staffordshire, and will trace the processes of manufacture. In the preparation of the earthenware clay some labour is required before it is in a fit state to be combined with the flint. It is first mixed with very pure water to the consistence of cream: this work is called *blunging*, and in large establishments is performed by means of machinery. The result is a smooth pulp, which is then passed through a series of sieves of increasing degrees of fineness, till at length it is perfectly fitted to enter into the composition of the ware. If the clay were moulded and dried without the addition of any other body, it would certainly crack; as the evaporation of the water with which it is mixed, in order to render it sufficiently plastic for the potter's wheel, would cause it to shrink in the proportion of one part in twelve in drying. In combination with siliceous earth in proper proportions, it bears the action of fire without cracking, while the silica materially improves the whiteness of the ware.

The flints are prepared by being burnt in a kiln, and removed while red hot from the kiln and thrown into cold water. By this operation their attraction of aggregation is lessened, and the labour of grinding them is much facilitated. They are then broken and ground to a very fine powder in a mill constructed for the purpose, the original of which was invented by Brindley. A quantity of water is thrown into the mill with the flints, by which the process is quickened and the health of the workman is preserved, the finer particles of flint being thus prevented from flying off and mixing with the atmosphere which the workmen inhale. The flints, when reduced to powder, are transferred from the mill into another vessel, where more water is added, and the whole is violently agitated by mechanical means; the finer parts are in consequence held in suspension above, and in this state are passed into a reservoir, while the grosser particles are left behind at the bottom of the vat. After subsidence, the supernatant water is drawn off from the reservoir, and the pulverised flint is in a fit state for use. It is considered of a proper fluidity for mixing with the clay when a pint weighs 32 ounces, while an equal measure of the diluted clay should weigh 24 ounces. The proportions in which the clay and flint are mixed vary with the quality of the clay, with the nature of the ware to be produced, and also with the practice of each manufacturer; the flint may form a fourth, a fifth, or a sixth part by weight of the prepared paste. The dilutions of clay and flint being brought together in suitable proportions, are intimately mixed by agitation, and passed, while in a state of semi-fluidity, through different sieves, whereby the whole becomes a smooth homogeneous mass. This mixture, technically called *slip*, is then very carefully evaporated, the mass being frequently stirred and turned over lest a part should become improperly hardened while the remainder continues too fluid. When the clay or paste is removed from the *slip-kiln*, it is well incorporated by beating it with wooden mallets, in order to expel the air which it contains. The next operation is that of cutting it into small pieces, which are thrown together again with all the strength of the workman; and this process is continued until the mass is considered to be in a complete state of consistence. When in this state, the mass is allowed to remain for a considerable period before being used, since it becomes more intimately united by time than by any mechanical means.

The paste, when taken for use, undergoes the process of *slapping*, which is similar in its effect to the last operation, and should incorporate the whole mass so completely, that wherever it is cut it should exhibit a perfectly smooth and uniformly close appearance. The clay, being thus prepared, is now ready for use.

The processes in the forming of earthenware are mainly of three different kinds—throwing, pressing, and casting, which are respectively employed according to the form of the article required.

The operation of *throwing* is performed upon a machine called a potter's lathe, and is used in shaping vessels which have a circular form. By this means the thrower moulds the clay into the form which he desires; chiefly by the fingers and palms of the hands, but in part also by wooden tools. When finished to his satisfaction he removes his work to a board or shelf, where it is left to dry partially; and when in a particular state of hardness, called the *green state*, well known to the operator, the vessel is in proper order for being further smoothed and shaped in the *turning-lathe*, and for being furnished with handles, spouts, or any other addition. The turning-lathe is similar to that used by the turner in wood, and by means of it, rings, rims, &c., are formed on the vessels. For making dishes, plates, and other similar shallow vessels, a plaster mould is used, which is placed on the block at the top of the upright spindle of the lathe; and the workman continues the process in nearly a similar manner as in throwing. When sufficiently dry to be taken from the mould, the edges are pared with a sharp knife, and the vessels are placed in piles and left to harden, preparatory to their being baked.

A machine called an *engine-lathe*, which has a horizontal movement backwards and forwards, in addition to the rotary motion, is used in giving to earthenware a milled edge. Handles, spouts, &c., are fixed on the vessels as soon as they are taken out of the turning-lathe. They are affixed by means of slip, with which the parts designed to come in contact are moistened; in a short time, when dry, the union of the parts is found to be perfect. Handles, &c., are made by pressure in a small metallic cylinder, which has an aperture in the centre of its bottom, to which plugs of various shaped orifices are fitted; there is likewise a piston, so fixed as to be worked by a screw up and down the cylinder. The cylinder being filled with clay, the piston is inserted, and forces the clay through the orifice at the bottom, and consequently gives it the same form as the aperture through which it was pressed. Being then cut into lengths and bent to the desired shape, the clay is ready, when sufficiently dry, to be joined to the vessel. For ornamental spouts, small ornaments, and other appendages of the like nature, the clay is pressed in moulds, the particular mode of doing which may be readily conceived.

When the vessels are sufficiently dry they have to be submitted to the action of fire. For this purpose they are placed in deep boxes called *seggars*, made of a mixture of fire-clay and old ground seggars, and capable of sustaining the most intense degree of heat without being fused. The seggars are of various sizes, shapes, and depths, adapted to the different pieces which they are to contain. In no case is one piece placed in or on another in the seggar, and all is so arranged that the heat may be equally applied to every part of each. The seggars, with their contents, are then disposed in the oven in such a way that the heat may be distributed fairly throughout: they are built one layer on the top of another until they reach nearly to the top of the oven, each seggar forming a cover to the one beneath it, and the upper seggar in each pile being always empty. The oven is of a cylindrical form, and very similar to the common kilns used for burning tiles. The process of baking usually lasts from forty-eight to fifty hours, during which time the heat is gradually increased, as it would be injurious to the ware to apply a very high degree at first. To ascertain when the baking has been carried far enough, the workman uses tests of common Staffordshire fire-clay, the pyrometer of Wedgwood having been long laid aside. When the appearance is considered satisfactory, the firing is discontinued, and the oven is suffered gradually to cool during twenty-four or thirty hours before the contents are taken out. The ware in this state is called *biscuit*. The glaze is now applied; the pieces are again placed in seggars, and conveyed to the glazing-oven, where heat is applied to them of sufficient intenseness to fuse the glaze; but the heat must by no means be so great as that to which the *biscuit* has previously been exposed, as the glaze would crack or peel off if the vessels were liable to any further shrinking.

The glaze generally used for common kinds of earthenware is a compound of litharge and ground flints, in the proportion of ten pounds of the first to four pounds of the latter. This method of glazing is however highly objectionable on account of its injurious effects on the health of the workman; while the lead being soluble by acids, makes a most pernicious glaze for vessels which are used for containing articles of prepared food. Glazes for porcelain and the finer kinds of earthenware are generally made with white lead, ground flints, ground flint-glass, and common salt. But almost every manufacturer uses a peculiar glaze of his own, the manner of making which he keeps in as much mystery as possible. Some glazes are made without the admixture of any lead, and in the whole of the better glazes this ingredient enters in so small a quantity as not to be injurious. The manner of applying the glaze is, to reduce the ingredients to powder, mix them with water to the consistence of cream, and then merely dip the pieces into the preparation, and withdraw them immediately, taking care that all the parts have been wetted with the glaze.

The kind called *dipped-ware* receives its coloured ornament in a singular way. After the basin or other vessel has been turned, it is fixed to a wheel, and made to rotate while the colouring is being effected. If, as is often the case, the colours are brown, yellow, and blue, the workman prepares three kinds of coloured liquid or creamy clay. A portion of these three he puts into a kind of funnel having three compartments, in such a manner that all three remain separate, and yet flow out of three adjoining apertures simultaneously. This funnel the workman holds over the vessel while revolving, in such a way that a little stream of tri-coloured paint shall drop upon it and form bands, stripes, spots, or curves; the three colours being contiguous, and yet distinct on the vessel.

When the earthenware is to be *printed*, it undergoes this process previously to glazing. It is thus performed: the landscape or pattern is engraved upon copper; the desired colour, being mixed with linseed-oil, is laid on the plate; and impressions are taken off on tissue-paper, in the manner usually employed by copper-plate printers. The paper, wet with the colour, has then all the blank parts cut away, leaving only the pattern entire, which is applied lightly to the ware when in the state of biscuit. It is then rubbed with a piece of woollen cloth, rolled tightly in the form of a cylinder, till the colour is pressed sufficiently into the ware. In this state the whole is left for an hour, when it is placed in a cistern of water, so that the paper becomes sufficiently moistened to peel off readily, having transferred to the biscuit the colour and impression which it had received from the copper-plate. When the pieces thus printed are sufficiently dry they are placed in an oven and exposed to a gentle heat, in order to dissipate the oil: they are then in a fit state to receive the glaze. Till within the last few years, blue produced from the oxide of cobalt was the only colour employed, but at present many other colours are printed with equal facility.

The art of painting, as applied to these interesting manufactures, relates to porcelain rather than to earthenware, and will be noticed in a later article [PORCELAIN]. The so-called *lustre-ware* is an earthenware to the surface of which a peculiar metallic effect is given. The metallic oxides used for this purpose are intimately mixed with some essential oil, and then brushed entirely over the surface of the vessel; the heat of the enamelling oven dissipates the oxygen, and restores the oxides to their metallic state, but with their brilliancy somewhat diminished. The imitation of gold and silver is very successful in some of these specimens.

One of the most important features connected with the English earthenware manufacture is the process just described, of imparting a pattern by means of printing, generally with a blue ink or pigment, but sometimes with black or other colours. Discussions have recently taken place, in reference to the *designing*, the *printing*, and the *applying* of these patterns, which it will be well briefly to notice here.

Concerning the designs for earthenware adornment, persons of taste have long speculated why the well-known willow pattern maintains its place so persistently in the market. Designs in every way more artistic are occasionally tried; but the dealers find this old pattern still sells the best, and therefore the potters adopt it more largely than any other. In 1856, Mr. Wallis, in a paper on 'Design as applied to Ceramic Manufactures,' read before the Society of Arts, adverted to the great influence exerted on the progress of the porcelain manufacture by the eminent firms of Minton and Copeland, and then made the following observations on the earthenware manufacture:—"Others have followed who, applying a better style of art to less exceptional articles than those produced by those two firms, have certainly aided in no slight degree the recent improvements. It is quite evident that at the present time, whatever fault may still be found with the subjects employed for decorating the cheaper wares, yet that the character of the art employed is much higher than formerly. In the blue-transfer ware, for instance, there is a decided tendency to mosaic forms, less attempt at projection in light and shadow; and although the details are more architectural than fictile, yet the result is felt to be more suited, alike to the use of the article, the surface decorated, and the method of ornamentation. In their forms, too, we can trace the influence of the merest elementary outlines in use in our schools of art, of which that established in the Potteries about eight years ago has been one of the most practically useful." There can indeed be no question that the designs are improving; and it is curious to observe the mode in which a reason has been sought for the persistence of that one particular pattern which no person pretends is artistic in any sense. In a discussion which followed the reading of Mr. Wallis's paper, Mr. Lockett, a well-known engraver for manufacturing purposes in Manchester, said:—"The world-wide celebrity of the willow-pattern in crockery is an instance of demand, where usefulness and economy are the chief considerations. The ware is well covered by the pattern; and in case of breakage there is no difficulty whatever in replacing them. The willow-pattern is to be found almost everywhere; whereas more elegant designs are often difficult, if not altogether impracticable, to replace; or they might require to be made expressly, if the manufacturer can be found, at extra cost and considerable inconvenience. I feel persuaded that the willow-pattern is seldom if ever bought for the beauty of the design; it is preferred only for its usefulness and convenience. Therefore the extensive demand for it ought not to be taken as a proof of deficient taste in the public."

In relation to the *engraving* of the designs, whatever they may be several suggestions have been brought forward within the last few years. Mr. Lander, an engraver of Bristol, has recently (1859) patented the following: He proposes to engrave the subject on a copper-plate; take as many electrotype copies from this as there are to be colours (supposing it to be a specimen of polychrome earthenware, which seems to be in Mr. Lander's view); erase portions from each cast, so that what is *left* on any one shall be *removed* from all the others; and then finish up each plate with the graver. A print is to be taken on paper, in the ordinary manner of colour-printing; that is, the plates are to be affixed to a frame, with guides to preserve the register; each plate is to be used only for one colour, and each is to be impressed on the paper in turn. It is obvious that this method will only be available for costly kinds of earthenware. Another suggestion is that made by Mr. Joubert, founded on the method of hardening copper-plates by *steeling* or *acierating*. Engraved copper-plates can, as is well-known, be multiplied almost without end by the electrotype process; thereby enabling one design to be available for an enormous number of printed impressions. These copper casts, however, are very soft, and yield only a few hundred impressions before they exhibit signs of wear, which are an eyesore to the engraver of high-class works. Hence, in 1857, M. Garnier, of Paris, tried the efficacy of copper-plates *coated with iron or steel after the engraving*, yet so exquisitely as not to injure the fineness of the lines. His experiments resulted in a patent taken out in 1858 by M. Jacquin. According to this patent, the engraved copper-plate is immersed in a trough containing a solution of a salt of iron, and containing also a sheet of iron. When the copper and the iron are placed in connection with the opposite poles of a galvanic battery, a complex electro-chemical action ensues, and a film of pure iron is deposited all over the engraved copper-plate, so wonderfully thin and uniform as to leave the handiwork of the engraver uninjured. A copper-plate so prepared has, it is asserted, been made to yield nearly as many impressions as another plate engraved on steel. When the beauty of the impressions begins to fade, the acierating may be repeated; and so a third, and still greater number of times. The controversy to which this invention has given rise among the engravers and printers of high-class works of art, we need not touch upon here; but it may be well to quote some observations made by Mr. Joubert in 1859, concerning the application of this principle to the printing of earthenware: "Some years ago, it was deemed desirable in potteries to supersede the necessity of having a large number of copper-plates engraved with the same design. Steel-plates were suggested; but the engravers found that they had to cut the lines so deep, in order to hold the large amount of colouring matter necessary, that there was great difficulty in using this hard metal. A further objection to the use of steel for this purpose, was that the smoothness of the surface prevented it from holding the oily description of colouring matter used. In the ordinary mode of printing, the cleaning of the surface of the plate is effected by the palm of the hand; but for earthenware, the plate is scraped with a spatula, and by that means the oily ink is apt to be dragged out of the lines." As a remedy for this evil, some of the potters have begun to use acierated copper-plates. Some persons have suggested that it would be better to acierate the *surface* of the plate only, leaving the engraved lines untouched—on the ground that copper receives the oily ink better than steel; but to this it has been replied, that a superior plan would be, to devise a new kind of colouring vehicle—which is quite within the range of inventive art. One more novel suggestion is all that we can make room for: Mr. R. Smith of Blackford has suggested that earthenware might receive a great variety of colours without the employment of engraved plates at all, by employing galvanic agency. Supposing a piece of earthenware to be about to receive a device in purple, he would place it for a few seconds in water; dip it into a solution of muriate of tin; connect the interior of the vessel with the negative pole of a galvanic battery by means of a strip of lead; connect a chain to the positive pole with a bit of gold wire at the end; and trace any device on the vessel by means of the gold wire, keeping the lead strip as near to it as possible on the inner surface. Mr. Smith conceives that a purple device would be produced by the chemical change of the ingredients into the purple precipitate of cassius. The colour would be baked in and glazed in the usual way. Or he would cut a pattern in gold foil; mount it on a band of gutta-percha; place the band round the vessel to press the gold close to the earthenware; and set the battery to work, to produce a pattern following the outline of that of the gold foil. To vary the effects, by producing blue or other colours instead of purple, platinum, palladium, silver, copper, iron, or cobalt, may be used instead of gold; and nitro-muriatic acid or ferro-cyanide of potassium instead of muriate of tin. The inventor appears to think that the precious metal deposited, from its extreme thinness, would not be so costly as the engraving, paper, printing, &c., in the ordinary method; but this, as well as many other points connected with the suggestion, remain to be proved.

We spoke above of one of the recent novelties as being concerned, not with the *designing* or *engraving*, but with the *applying* of the device. This is the remarkable method recently patented by Mr. Collins. He can enlarge or diminish an engraving without re-engraving the plate. The processes are not yet placed before the public in such a form that they can be described minutely; but their rationale is somewhat as follows: Let us suppose, first, that the device is to be enlarged. It is engraved on copper; an impression is taken from it, with a peculiar ink and in a peculiar way, on the flat surface of a substance in which india-rubber is the chief ingredient; this surface is stretched by a most careful process, acting on every part of it equally, so as to produce no distortion of the device, although it may be twice as long and broad, or cover four times the area, as before. From this stretched surface an electrotype cast is obtained; and from this cast impressions may be printed on paper. Let us suppose, on the other hand, that the device is to be diminished. It is engraved on copper; an impression is taken from this on an india-rubber surface *already in a state of tension*—that is, the surface is stretched before instead of after the taking of the impression. The tension is then removed, by which the surface is brought back to its original size; and the device appears upon it in a much smaller form than on the original copper-plate: perhaps only one half as long and broad, or covering only one-fourth the area. An electrotype cast is taken, and the printing proceeds. An engraving may thus be copied on an enlarged or a diminished scale, without re-engraving. The possible applications of this very remarkable invention to the fine arts, we will not touch upon in this article; but it may be well to mention that a joint-stock company, now forming for carrying out the patent, counts much upon its valuable employment in printing earthenware. Staffordshire now produces sets, or suites, or services of useful earthenware, in which the same pattern is depicted on all the cups, saucers, plates, dishes, basins, and other pieces—some small and some large; some circular and others oval. Hitherto it has been necessary to engrave as many plates as there are sizes and shapes in the suite; but now it is hoped that one plate will suffice for all or nearly all. It can be expanded or contracted to suit circular articles of different diameters; or, if stretched or contracted more in one direction than the other, it can transform a circular device into an oval. Specimens have already been produced, showing the application of this principle in a very striking way.

The earthenware factories of England are mostly situated in that remarkable district of Staffordshire known as the Potteries. The towns, considered topographically, are noticed in the GEOGRAPHICAL DIVISION of this CYCLOPÆDIA; therefore we may, in this place, simply say of them that Tunstall, Burslem, Cobridge, Hanley, Shelton, Etruria, Stoke, Fenton, Longton, and Lane End, and many other places whose names are less known, form virtually one town ten miles long, almost the whole of the inhabitants of which are supported by the earthenware and porcelain manufactures. Good clay is found there for the seggars or baking vessels, and for bricks for kilns, &c.; cheap coal is dug in the vicinity; and there is easy transport, by canal and railway, to the great shipping port at Liverpool. The pottery works (often called *banks* by the work-people) have a general similarity one to another. Each presents to view on the exterior its large, lofty, dark-coloured structures, which are the hovels or casings surrounding the ovens in which the ware is baked; and each has in its immediate neighbourhood whole streets of houses, in which the work-people reside. Inside, the buildings generally surround a large number of open courts or passages. There is little symmetry or elegance, for many of the establishments have gradually grown by the addition of new buildings to those originally used. So vast are the quantities made, that each cluster of buildings is usually devoted to a particular branch of the manufacture—dishes in one building, plates in another, saucers in a third, coloured ware in a fourth, printed ware in a fifth, and so on.

The extent of the earthenware and porcelain manufacture in England is not correctly known; a few years ago it was roughly estimated at 2,500,000*l.* annually. Of the exports we have better means of judging. The declared values in three years, separated by intervals of seven years apart for the purpose of comparison, were set down thus:—

	£
1844	766,000
1851	1,121,000
1858	1,151,000

This last named value is supposed to have been represented by about 100 million pieces; if so, it presents an average of less than threepence each piece or vessel, showing that the bulk of the export is in the form of common cheap earthenware; indeed the familiar earthenware plates, cups, and saucers, are the chief articles. From the following entries it will be seen that the United States are our best customers for these commodities:—

			£
Exported in 1858	to the	United States . . .	379,000
,,	,,	Brazil	92,000
,,	,,	British America . .	54,000
,,	,,	East Indies . .	82,000
,,	,,	Australia	106,000
,,	,,	Other countries . .	438,000

The time seems to be approaching when the United States will make earthenware for themselves, instead of buying so largely from us. At Pittsburg in Pennsylvania, and at Liverpool on the Ohio, large pottery establishments have arisen within the last few years. Missouri supplies fine clay for earthenware, and Delaware still finer for porcelain; and as fuel is cheap, the manufacturers are now largely producing for the western states of the Union. A kind of queen's ware is made, with raised devices on a cobalt blue glaze. There is also a flint-enamelled ware, made from a very white clay found near Charleston. One peculiar manufacture is that of earthenware knobs for common locks; they are made of a striated mixture of red and yellow clay, coated with a strong brown glaze; and a hole for the spindle is made by the process of casting the knob. The article produced is cheap, durable, and convenient.

The continent of Europe produces no earthenware, in quality and price combined, equal to that of England. The ceramic manufactures are there eminent rather for the porcelain than the earthenware. [PORCELAIN.]

EARTHQUAKES are the most terrific of all natural phenomena. The solid surface of the globe is put in motion by them, and assumes an appearance which in some cases may be compared with the sea when agitated by the wind.

The least dangerous of these phenomena are those which by the Creoles of South America are called *Tremblores*, a term which may be translated by *tremors*. The surface of the earth is put in a trembling motion, by which such objects as are not well supported are thrown to the ground, and even walls are split, but the damage does not extend farther. Life is safe, and property but slightly injured. These tremors are by far the most common kind of earthquakes, and occur in some countries of South America, especially in Chile, almost every day, at least in certain seasons.

The *terremotos* of the Creoles, or proper earthquakes, give to the surface either horizontal oscillations, not dissimilar to the waves of an agitated sea, or they consist in violent perpendicular upliftings, so that it would seem as if repeated explosions were exerting their force against the roof of a subterraneous cavern, threatening to burst it open and to blow into the air everything placed over it. By these earthquakes walls are overthrown, and fissures are produced in the ground. The latter are frequently more than a foot in width, and sometimes water gushes out of them like a fountain.

Nothing makes such an awful impression on the senses as an earthquake. The earth is violently convulsed, heaving up and down in a manner hardly conceivable by those who have not witnessed it. The tottering buildings, the falling of the tiles, and the crashing of the timbers of the roofs, completely distract the senses. Fear drives men from their houses; but they do not always find safety out of doors. No person can stand without support: people cling to one another, to trees, or to posts. Some throw themselves on the ground; but the motion of the earth is so violent that they are obliged to stretch out their arms on each side to prevent themselves from being tossed over. Animals are equally alarmed. They stand with their legs spread out and their heads down, trembling violently. The air itself seems to participate in the convulsion, for the birds fly about wildly. Meanwhile the sea retires from the shore; but after a few minutes it returns in a high wave, which advances like a watery wall with incredible velocity, and covers all those tracts which are not more than fifty feet above high-water mark. It rushes back with equal velocity. This motion of the sea is repeated as long as the shocks of the earthquake are violent. Vessels sailing along a coast convulsed by an earthquake feel also a motion quite different from that produced by gales or currents. The loss of life by earthquakes is sometimes considerable. It is chiefly produced by the falling of the buildings when the shock is so unexpected that the inhabitants have not time to escape. In some cases the overflowing of the sea has been fatal to a great number of persons. People have also been swallowed up by the fissures caused by earthquakes.

Earthquakes are generally preceded and sometimes attended by a subterraneous noise, which is compared by some to that of a very heavy artillery waggon rolling quickly over a stone pavement at a distance; by others, to the echo of distant thunder in a mountainous country. It is worthy of remark that this noise is sometimes heard without any earthquake taking place, as in 1784, at Guanaxuato, in Mexico, and that it has been as audible in places situated at a considerable distance from the seat of the earthquake as in those which experienced the shocks. There are also many cases on record in which the earthquakes have not been attended by such subterraneous noise.

The single shocks of an earthquake last from a few seconds to two or three minutes. Sometimes they follow one another at short intervals. It is remarkable that generally either the first or one of the first shocks is the most violent, and that they afterwards gradually decrease in force. Sometimes they return for several days, and even weeks; and in some places, as at Copiapò, in Chile, they are of daily occurrence.

Earthquakes are sometimes experienced over an immense tract of country. The great earthquake in Chile (in 1835) was felt at all places between the Island of Chiloe (40° S. lat.) and Copiapò (27° S. lat.): consequently over 13° of latitude. It extended from the island of Juan Fernandez to the town of Mendoza, on the east side of the range of the Andes, over 10° of longitude. But when earthquakes extend over such an immense tract of country, some districts are always convulsed with greater violence, and these may be considered as the centre of the earthquake. The farther a place is removed from these centres, the less violent, as a general rule, are the shocks.

We know little, or rather nothing, of the origin or cause of earthquakes. It may, however, be considered as certain that they are due to the same agency which produces volcanic eruptions. These eruptions are frequently preceded by earthquakes; and whenever, in places situated near active volcanoes, it is observed that no smoke issues from their craters, the inhabitants begin to fear the approach of an earthquake.

It is not quite certain whether or not there is any connection between the state of the atmosphere and the phenomena of earthquakes. It is not improbable that such is the case with the slighter shocks, the *tremblores*. They commonly occur, or at least are by far most frequent, at the time of the changes of the seasons, in Guatemala as well as in Chile. But the more violent concussions seem to be quite independent of the seasons, and they occur both in calm and cloudless weather and in storms and during rain. In some instances they have been preceded by luminous meteors.

Ancient authors, especially Thucydides, frequently mention earthquakes; but only in general terms. Yet we learn enough from these slight notices to show that they were often equal in violence to those which in modern times have convulsed the continent of Europe and Asia. (Thucyd. i. 101; iii. 89; v. 50; viii. 41.) No detailed description of an earthquake in Europe or in the old continent exists before that which, on the 1st of November, 1755, almost destroyed the city of Lisbon. This is probably the most destructive earthquake which has ever occurred in Europe. The number of persons that perished by it is stated to have been 30,000. In February and March, 1783, the north-eastern part of Sicily and the southern portion of Calabria were convulsed by repeated and violent shocks, which overthrew the town of Messina, and killed many thousands of its inhabitants, as well as many persons in Calabria. One of the last considerable earthquakes in Europe extended over the middle of the kingdom of Naples, and was most destructive in the districts lying along the declivities of Mount Matese (41° 30′ N. lat.). The number of persons who perished by it amounted to 3274, besides 1615 who were wounded. In 1857, on December 16, two shocks of earthquake were felt in Southern Italy, especially in the province of Basilicata, by the destruction of buildings occasioned by which, at least 22,000 human beings were destroyed and 4000 wounded. It has been computed by Dr. Lacaita, that in the course of seventy-five years, from 1783 to 1857, the kingdom of Naples lost at least 111,000 inhabitants by the effects of earthquakes, or more than 1500 per year, out of an average population of 6,000,000.

On the first day of the year 1837, the countries along the eastern extremity of the Mediterranean, especially Syria, were violently agitated by an earthquake. The towns of Damascus, Acre, Tyre, and Sidon, suffered great damage, and Tiberias and Safet were entirely destroyed. It is stated that about 6000 lives were lost.

America is more subject to earthquakes than any portion of the Old World (except perhaps the Indian Archipelago and its vicinity), but they are only strongly felt between 20° N. lat. and 40° S. lat.; and it is not the whole country included between these latitudes that is visited by them, but only the table-lands of the Mexican isthmus, the Andes, and the countries bordering on them, and those which are adjacent to the Caribbean Sea. Mention of earthquakes in these countries occurs in the Spanish historians of the Conquest; but it would seem as if the earthquakes were less destructive formerly than in the last century. In 1717 the town of Guatemala was greatly damaged by an earthquake on the 29th of September; and on the 29th of June, 1773, the town was almost entirely destroyed. Caracas was destroyed by an earthquake on the 26th of March, 1812, when upwards of 12,000 of its inhabitants were buried in the ruins; and the same town experienced, in 1826, another earthquake, which was hardly less destructive. Bogotà experienced a very severe shock in 1827. On the table-land of Quito violent earthquakes are frequent. In 1698, on the 20th of June, Lacatunga and Hambato were destroyed; and on the 4th of February, 1797, the town of Quito was greatly damaged, and Riobamba levelled to the ground. Not less than 40,000 persons are stated to have perished by this last earthquake on the table-land. Lima and the countries about it are likewise subject to frequent and violent earthquakes. The town of Lima was almost entirely destroyed on the 20th of October, 1687, and again on the 28th of October, 1746. In this latter catastrophe the port of Callao was inundated by the sea, and the whole population perished. Arequipa has had its share of earthquakes; but the last violent one occurred in 1725. Copiapò was destroyed on the 11th of April, 1819, and again in 1822. By this last earthquake, which happened on the 19th of November, the town of Valparaiso was levelled to the ground. Santiago has suffered largely from the destructive effects of the earthquakes so frequent in Chile: on the 8th of July, 1730, it sustained great damages. But no place in Chile has so frequently been destroyed as Concepcion. It was first destroyed by the united effects of repeated shocks and the inundation of the sea in 1730, and again in the same manner in 1751. After this the town was rebuilt on another site; but this new town and its port of Talcahuano were entirely demolished on the 20th of February, 1835. A most graphic description of this dreadful earthquake is given in the 'Journal of the Royal Geographical Society of London,' vol. vi. p. 319, &c., to which we are much indebted for several valuable facts and remarks. The inundation of the sea during this calamity may be compared with the narrative of a similar event recorded by Thucydides (iii. 89).

Since the preceding sketch of the circumstances attending earthquakes was first published, great attention has been given to the philosophical investigation of their phenomena; in which Mr. R. Mallet, M. Inst. C.E., F.R.S., and M. Perrey, of Dijon, have taken the lead. From the researches of the first, there is every reason to consider it established that an earthquake is simply "*the transit of a wave or waves of elastic compression in any direction, from vertically upwards to horizontally in any azimuth, through the crust and surface of the earth, from any centre of impulse or from more than one, and which may be attended with sound and tidal waves, dependent upon the impulse and upon circumstances of position as to sea and land.*" Four elaborate

Reports on the facts and theory of earthquake phenomena have appeared in those of the British Association for the Advancement of Science, for the years 1850, 1851, 1854, and 1858, by Mr. Mallet and his son Dr. J. W. Mallet, to which we may refer, as incorporating almost everything that is known respecting earthquakes; and the fourth includes a most valuable bibliography of the subject. Mr. R. Mallet is also the author of the article 'On Observation of Earthquake Phenomena,' in the 'Admiralty Manual of Scientific Enquiry,' 3rd edit., Lond., 1859, p. 325-363, from which the foregoing definition is cited.

From the investigations contained or recorded in these works have resulted the new sciences or departments of science termed SEISMOLOGY and SEISMOMETRY, an article on which, containing also additional facts of earthquake phenomena, will be found in its proper place.

EARTHS. This term is sometimes applied in chemistry to denote the oxides of those metals of which aluminium is a type. The earths are Alumina, Thorina, Glucina, Zirconia, Erbia, and Terbia. The name *alkaline-earths* is, in like manner, applied to Baryta, Strontia, Lime, and Magnesia. Further information respecting these bodies will be found under the respective names of the metals, ALUMINIUM, THORINUM, GLUCINUM, ZIRCONIUM, ERBIUM, TERBIUM, BARIUM, STRONTIUM, CALCIUM, and MAGNESIUM.

EASEL (derived by some from the Teutonic *asel*, or *esel*, an ass), the wooden frame, furnished with a set of moveable pegs, or more convenient rack and sliding ledge, on which pictures are placed while being painted, and which raises or lowers them according to the artist's convenience. Its antiquity is manifest, from its appearance in pictures discovered in Herculaneum. Several modifications have been made in the form of easels and in the apparatus for raising and lowering the pictures, but the principle is the same in all.

EASEMENT (from the French words *aise*, *aisement*, ease), is defined by the old law writers as a service or convenience which one neighbour hath of another by charter or prescription without profit; as a way through his ground, a sink, or the like. It includes rights of way, water-courses, ancient lights, and various other franchises, issuing out of corporeal hereditaments, and sometimes, though inaccurately, is applied to rights of common.

At the common law these privileges (which can only be created and transferred by deed) might be claimed either under an immemorial custom or by prescription; but 20 years uninterrupted and unexplained enjoyment of an easement formerly constituted evidence for a jury to presume that it originated in a grant by deed; except in the city of London, where the presumption of a grant from 20 years' possession of windows was excluded by the custom which required that there should exist "some written instrument or record of an agreement." Nonuser during the same period was also considered an extinguishment of the right, as raising a presumption that it had been released.

By the statute 2 & 3 Will. IV. cap. 71, several important alterations were made with regard to this description of property: 40 years' enjoyment of any way or other easement, or any water-course, and 20 years uninterrupted "access and use of any light to and for any dwelling-house," &c., now constitute an indefeasible title, unless the owner enjoys "by some consent or agreement expressly given or made for that purpose by deed or writing." The same statute also enacts that nonuser for the like number of years (according to the description of the particular right) shall preclude a claim to it. The custom of London is indirectly excluded by this statute.

The easements of the English correspond to the Servitutes of the Roman and the Servitudes of the French and Scotch laws. The servitutes were a class of rights which gave rise to numerous complicated questions. Those of road, water, light, drains, were the principal.

(*Dig.* l. viii. *De Servitutibus*; *Code Civil*, l. ii. tit. 4, *Des Servitudes*; Ersk. Inst., *Servitudes*.)

EAST. The point of the compass which is in a direction at right-angles to that of north and south, and which is towards the *right* hand of a spectator who faces the north. The distinction between east and west must ultimately be derived from a reference to the human body; for we can only define a spectator's *right* hand by saying that it is the hand which is not upon the same side as the heart.

EAST INDIA COMPANY. This association originated from the subscriptions, trifling in amount, of a few private individuals. It gradually became a commercial body with gigantic means, and next, by the force of unforeseen circumstances, assumed the form of a sovereign power, while those by whom it was directed continued in their individual capacities to be without power or political influence; thus presenting an anomaly without a parallel in the history of the world.

The company was first formed in London in 1599, when its capital, amounting to 30,000*l*., was divided into 101 shares. At the end of the next year the adventurers obtained a charter from the crown, under which they enjoyed certain privileges, and were formed into a corporation for fifteen years, under the title of 'The Governor and Company of Merchants of London trading to the East Indies.' Under this charter the management of the company's affairs was intrusted to 24 members of a committee chosen by the proprietors from among their own body, and this committee was renewed by election every year.

The first adventure of the association was commenced in 1601. In the month of May of that year, five ships, with cargoes of merchandise and bullion, sailed from Torbay to India. The result was encouraging, and between 1603 and 1613, eight other voyages were performed, all of which were highly profitable, with the exception of the one undertaken in the year 1607. In the other years the clear profits of the trade varied from 100 to 200 per cent. upon the capital employed. At this time the trading of the Company was not confined to the joint stock of the corporation, but other adventurers were admitted, who subscribed the sums required to complete the lading of the ships, and received back the amount, together with their share of the profits, at the termination of every voyage.

The charter of the Company was renewed for an indefinite period in 1609, subject to dissolution on the part of the government upon giving three years' notice to that effect. In 1611 the Company obtained permission from the Mogul to establish factories in Surat, Ahmedabad, Cambaya, and Goga, in consideration of which permission it agreed to pay to that sovereign an export duty upon all its shipments at the rate of 3½ per cent.

After 1612 subscriptions were no longer taken from individuals in aid of the joint-stock capital, which was raised to 420,000*l*., and in 1617-18 a new fund of 1,600,000*l*. was subscribed. This last capital, although managed by the same directors, was kept wholly distinct from the former stock, and the profits resulting from it were separately accounted for to the subscribers.

The functions of government were first exercised by the Company in 1624, when authority was given to it by the king to punish its servants abroad either by civil or by martial law, and this authority was unlimited in extent, embracing even the power of taking life. In 1632 a third capital, amounting to 420,700*l*., was raised, and its management, although confided to the same directors, was also kept distinct from that of the first and second subscriptions. It is uncertain whether the capitals here severally mentioned were considered as permanent investments or were returned to the subscribers at the termination of each different adventure.

A rival association, formed in 1636, succeeded in obtaining from the king, who accepted a share in the adventure, a licence to trade with India, notwithstanding the remonstrances of the chartered body, of whose rights this was deemed an infringement. Promises indeed were given that the licence should be withdrawn, but these promises were never fulfilled; and after carrying on their trade for several years in a spirit of rivalry which was fatal to their prosperity, the two bodies united in 1650, and thenceforward carried on their operations under the title of "The United Joint Stock." In 1652, the Company obtained from the Mogul the grant of a licence for carrying on an unlimited trade throughout the province of Bengal without payment of duties.

Some proprietors of the Company's stock becoming dissatisfied with the management of the directors, obtained from Cromwell, in 1655, permission to send trading vessels to India, and nominated a committee of management from their own body, for which they assumed the title of "The Merchant Adventurers." The evils to both parties of this rivalship soon became apparent, and in about two years from the commencement of their operations the Merchant Adventurers threw their separate funds into the general stock under the management of the directors. On this occasion a new subscription was raised to the amount of 786,000*l*. In April, 1661, a new charter was granted to the Company, in which all its former privileges were confirmed, and the further authority was given to make peace or war with or against any princes and people "not being Christians;" and to seize all unlicensed persons (Europeans) who shall be found within the limits to which its trade extended, and to send them to England. This formed and continued to be the East India Company.

The acquisition of territorial possessions, the nature of the productions of such territories, and of the trade of the Company, are all explained under the head of HINDUSTAN, in GEOG. DIV.; and in the separate articles BENGAL, BOMBAY, MADRAS, ASAM, SINDE, &c., with the nature of the government up to the alteration made by the 21 & 22 Vict. cap. 106, passed August 2, 1858, by which all the territories heretofore under the government of the East India Company are vested in her Majesty. By the act a new Secretary of State for India is appointed, assisted by a council of fifteen, of whom seven are to be elected by the directors of the old Company, and eight are nominated by the crown. Interest at the rate of 10 per cent. on the capital of the old Company is charged on the revenue of India. Directors are still to be elected, as before, by the proprietors, but their functions extend but little beyond electing the members of the council on occasion of a vacancy, and paying the dividends to the proprietors. All property possessed by the Company in their corporate capacity was also vested in her Majesty, and the troops employed by it were transferred to her Majesty's service, and have become her Majesty's Indian army.

EASTER, Anglo-Saxon *Eastre*, a moveable feast, held in commemoration of the Resurrection; being the most important and most ancient in observance, it governs the whole of the other moveable feasts throughout the year. In the Greek and Latin churches it is called Πασχα, *Pascha*, originally derived from a Hebrew word signifying a passage, which was the name given to the great feast of the Passover, held by the Jews on the same day with that on which our Saviour held his paschal feast. The etymologies of the word Easter have been various.

Bede says it was derived from a goddess called *Eostre*, to whom the people used at this season to celebrate festivals. Wheatley ('On the Common Prayer') says it is from the Saxon *Oster*, to rise; another derivation is from the Anglo-Saxon *yst*, a storm, the time of Easter being subject to the continual recurrence of tempestuous weather.

That the observation of Easter is as ancient as the time of the Apostles seems undoubted. In the 2nd century, however, a controversy arose as to the exact time of its celebration. The Eastern churches kept it on the 14th day of the first Jewish month; the Western churches on the night which preceded the anniversary of our Saviour's resurrection. The inconvenience of the former was, that this festival was commonly held upon other days of the week than the first, or Sunday, which was undoubtedly the proper day. The disputants retained their respective customs till towards the middle of the 4th century, when the rule for the celebration of Easter was fixed by the Council of Nice, A.D. 325. It was ordered to be held on the Sunday which falls next after the first full moon following the 21st of March, or vernal equinox. But the calculation for the full moon of the Calendar does not always follow that for the full moon of the astronomer, as was the case in 1845. For the true method of finding Easter, see the following article.

Brand, in his 'Popular Antiquities,' has given a long enumeration of the sports and observances at Easter in former times, including a few superstitions. The mutual presentation of coloured eggs at this season from friends continues both in the East and in Russia. *Lifting*, originally designed to represent our Saviour's resurrection, is also still practised on Easter Monday and Tuesday in England, in Lancashire and some other counties. Tansey puddings and cakes were anciently eaten in England at Easter.

EASTER, Method of Finding. The importance of this question, in aiding historical reference, is confined to that definition of Easter Sunday which was finally adopted by the Western Church. As this definition is given in the prayer-books of the establishment in a manner which has led to misconceptions, we here give an amended version of that definition, which truly represents the tables of the Gregorian Calendar, being the very tables which the English Church uses. Easter day, on which the rest of the moveable feasts depend, is always the first Sunday *after* the *fourteenth day* (not the *full moon*) of the *calendar moon* (not the moon of the heavens, nor even the mean moon of the astronomers) which happens *upon or next after* the 21st of March, according to the rules laid down for the construction of the calendar; so that if the fourteenth day happen upon a Sunday, Easter day is the Sunday after.

By common consent, it is not the real sun or the real moon which is employed in finding Easter, but the fictitious sun and moon of astronomers, which move uniformly with the average motion of the real bodies: and even these, as we shall see, are only used to construct a *calendar moon* for ecclesiastical convenience. It must therefore never surprise any one to find the Easter of any year not agreeing with the moon to a day, since such a case might (and sometimes must) arise. But the following rules will determine the Easter day of chronologists in any year of the Christian era, which is all that is required:—

First, ascertain the dominical letter, taking the second where there are two. [DOMINICAL LETTER.] Next, ascertain the golden number (year of the Metonic cycle) as follows: add one to the date of the year and divide by 19, the remainder (or if there be no remainder, 19 itself) is the golden number. The following table must then be used, in the manner to be immediately explained:—

	O. S.	N. S.		O. S.	N. S.
March 21 C	16	14	April 9 A	17	15
„ 22 D	5	3	„ 10 B	6	4
„ 23 E	..	..	„ 11 C	..	..
„ 24 F	13	11	„ 12 D	14	12
„ 25 G	2	..	„ 13 E	3	1
„ 26 A	..	19	„ 14 F	..	..
„ 27 B	10	8	„ 15 G	11	9
„ 28 C	..	..	„ 16 A	..	..
„ 29 D	18	16	„ 17 B	19	17
„ 30 E	7	5	„ 18 C	8	6
„ 31 F	..	..	„ 19 D	..	..
April 1 G	15	13	„ 20 E	..	..
„ 2 A	4	2	„ 21 F	..	..
„ 3 B	..	..	„ 22 G	..	..
„ 4 C	12	10	„ 23 A	..	..
„ 5 D	1	..	„ 24 B	..	..
„ 6 E	..	18	„ 25 C	..	..
„ 7 F	9	7			
„ 8 G	..	..			

O. S. means *old style*; N. S., *new style*.

Having the golden number, and the dominical letter, find out the golden number in the second or third column, according as old style or new style is meant; and look down the first column until the *next* occurrence of the dominical letter comes. Easter day is opposite. Thus the golden number being 13 and the dominical letter F, Easter day is March 31 in the old style, April 7 in the new style.

Example 1.—What was Easter day A.D. 1688 (old style)?
The dominical *letters* are A G. Take the second, G.

1688
1

19)1689(88
rem. 17 the golden number.

Opposite to 17, under O. S., comes April 9 A, and the next G which occurs is opposite April 15, which was therefore Easter day.

Example 2.—When did Easter day fall, A.D. 1841?
The dominical letter is C.

1841
1

19)1842(96
rem. 18 the golden number.

Opposite to 18, under N. S., is April 6 E, and the next C is opposite to April 11, which is therefore Easter day.

The following table gives Easter day for every year from 1800 to 1999. Thus in 1873 Easter day is April 13 (a. 13); in 1973 it is April 22 (a. 22).

	18.	19.		18.	19.		18.	19.
00	a. 13	a. 15	34	m. 30	a. 1	67	a. 21	m. 26
01	a. 5	a. 7	35	a. 19	a. 21	68	a. 12	a. 14
02	a. 18	m. 30	36	a. 3	a. 12	69	m. 28	a. 6
03	a. 10	a. 12	37	m. 26	m. 28	70	a. 17	m. 29
04	a. 1	a. 3	38	a. 15	a. 17	71	a. 9	a. 11
05	a. 14	a. 23	39	m. 31	a. 9	72	m. 31	a. 2
06	a. 6	a. 15	40	a. 19	m. 24	73	a. 13	a. 22
07	m. 29	m. 31	41	a. 11	a. 13	74	a. 5	a. 14
08	a. 17	a. 19	42	m. 27	a. 5	75	m. 28	m. 30
09	a. 2	a. 11	43	a. 16	a. 25	76	a. 16	a. 18
10	a. 22	m. 27	44	a. 7	a. 9	77	a. 1	a. 10
11	a. 14	a. 16	45	m. 23	a. 1	78	a. 21	m. 26
12	m. 29	a. 7	46	a. 12	a. 21	79	a. 13	a. 15
13	a. 18	m. 23	47	a. 4	a. 6	80	m. 28	a. 6
14	a. 10	a. 12	48	a. 23	m. 28	81	a. 17	a. 19
15	m. 26	a. 4	49	a. 8	a. 17	82	a. 9	a. 11
16	a. 14	a. 23	50	m. 31	a. 9	83	m. 25	a. 3
17	a. 6	a. 8	51	a. 20	m. 25	84	a. 13	a. 22
18	m. 22	m. 31	52	a. 11	a. 13	85	a. 5	a. 7
19	a. 11	a. 20	53	m. 27	a. 5	86	a. 25	m. 30
20	a. 2	a. 4	54	a. 16	a. 18	87	a. 10	a. 19
21	a. 22	m. 27	55	a. 8	a. 10	88	a. 1	a. 3
22	a. 7	a. 16	56	m. 23	a. 1	89	a. 21	m. 26
23	m. 30	a. 1	57	a. 12	a. 21	90	a. 6	a. 15
24	a. 18	a. 20	58	a. 4	a. 6	91	m. 29	m. 31
25	a. 3	a. 12	59	a. 24	m. 29	92	a. 17	a. 19
26	m. 26	a. 4	60	a. 8	a. 17	93	a. 2	a. 11
27	a. 15	a. 17	61	m. 31	a. 2	94	m. 25	a. 3
28	a. 6	a. 8	62	a. 20	a. 22	95	a. 14	a. 16
29	a. 19	m. 31	63	a. 5	a. 14	96	a. 5	a. 7
30	a. 11	a. 20	64	m. 27	m. 29	97	a. 18	m. 30
31	a. 3	a. 5	65	a. 16	a. 18	98	a. 10	a. 12
32	a. 22	m. 27	66	a. 1	a. 10	99	a. 2	a. 4
33	a. 7	a. 16						

Some years, such as 1818 and 1845, are made remarkable by Easter Sunday being kept in direct defiance of the statement made in the Act of Parliament (24 Geo. II. cap. 23), by which it is "the first Sunday after the *full moon* which happens upon or next after the 21st day of March; and if the full moon happens upon a Sunday, Easter Day is the Sunday after." The act which makes this statement also prescribes rules; that is, copies the rules of the Gregorian calendar, and the tables constructed from them. According to the rules and tables, Sunday, March 23rd, was Easter Day of 1845. But the full moon was on this very day, at past 8 o'clock in the evening; so that by the explanation, Easter day ought to have fallen on the 30th. The error arises from a mistake and an omission in the Act of Parliament: Easter was never determined by the day of the "full moon," but by the "*fourteenth day* of the moon," which words ought to have been written instead of "full moon;" and, moreover, the moon of the calendar is not the moon of the heavens, but an imaginary moon in advance of it, contrived for reasons we shall presently mention. The definition at the beginning of this article has the mistakes corrected.

We shall in this article give as much of the history of Easter, and of the reformation of the calendar, as may explain the discussions upon this subject, referring for fuller information to an article 'on the Ecclesiastical Calendar' in the 'Companion to the Almanac' for 1845, and to some supplemental information in the same work for 1846. A sharp discussion occurred in 1818, at which period we cannot ascertain that the true explanation was given by any one: the discussion of 1845 was checked by the article first referred to. When it next happens, the same misunderstandings will be repeated, unless either the explanation given by the Act of Parliament be altered in the mean time, or works of reference be made to contain an account free from the usual errors.

The disputes which agitated the Christians of the 2nd century respecting the observance of Easter depended upon two questions:

first, whether the feast was to be a version of the Passover, to be kept on the fourteenth day of the moon, or an anniversary of the Resurrection, to be kept on the first day of the week; secondly, in what manner the full moon was to be predicted. The details of this dispute do not affect us here, except in one point. It seems clear that towards the end of the 2nd century, the Metonic cycle of nineteen years was frequently introduced into the reckoning. It is the peculiarity of this cycle of nineteen years [Periods of Revolution], that the new and full moons return to the same days of the month, generally speaking; that if, for instance, a full moon fall on the 10th of March in any year, it is most likely to fall on the same day in nineteen years, and certainly on the 9th or 11th, if not on the 10th. The astronomers, and all who predicted celestial phenomena for common use, used this Metonic cycle; several modern writers on ecclesiastical history speak as if the Christians had invented the cycle of the golden number, which is only the Metonic cycle with its commencement altered. But it is material to notice that all countries unto which Greek civilisation had found its way, had their new and full moons predicted by this cycle.

The Nicene Council (A.D. 325) attempted to bring about a general usage in keeping Easter. What is left of this council is its creed, a synodical epistle, and twenty canons. Whether those canons which now exist be the genuine work of the Nicene Council is nothing to our present purpose, for they do not mention Easter at all; nor should we have noticed them here, had we not seen them cited by name in reference to Easter, to give, as it were, an impression that the council had laid down rules on the subject in a definite form. All their interference in the matter, as far as it can be collected from the earliest historians of the council, Socrates and Theodoret, is contained in one sentence of the synodical epistle, as follows:—"We also send you the good news concerning the unanimous consent of all in reference to the celebration of the most solemn feast of Easter, for this difference also has been made up by the assistance of your prayers; so that all the brethren in the East, who formerly celebrated this festival at the same time as the Jews, will in future conform to the Romans and to us, and to all who have of old observed our manner of celebrating Easter." The case is clear enough: there was a great schism between the Easterns and Westerns,—not an astronomical schism, but a part of the great conflict between the Jewish and Gentile Christians; and the council simply decreed that the former should adopt the usual practice of the latter. St. Ambrose, in the next generation, in a letter written A.D. 386, says that the council had got up the method of the cycle of nineteen years, which they had named *Enneadecaëteris*; that is, Ambrose was not astronomer enough to know that both the thing and the name had been current even in elementary works for hundreds of years before the council. In this, as we have mentioned, he has had followers; indeed, the necessity of accounting for the cycle of nineteen years in some way, and the want of knowledge of its astronomical history, has in a manner compelled theological writers to lay it at the door of the Nicene bishops, and thence to infer that they paid a very particular attention to the astronomical part of the settlement of Easter. But in fact their object was merely to keep the Eastern Christians from celebrating the Jewish Passover. So long as this point was gained, they do not seem to have thought it necessary to interfere, even as regarded the East, with those differences of astronomical method, which they do not even mention, though they could not be ignorant that they existed in the West. And the result was as follows: from the time of the Nicene Council little or nothing more is heard about celebrating Easter on the 14th, instead of the Sunday after, while the disputes about the astronomical cycle of Easter recommenced almost immediately, and lasted for centuries.

Eusebius of Cæsarea, the historian, informs us in his life of Constantine that he had presented to that emperor a treatise on Easter, wherein the mystic character of that festival was explained; apparently a purely theological work. Jerome ('de Scriptor. Eccles.') mends this statement, and informs us that Eusebius was the author of the cycle of nineteen years. Bede and others have copied Jerome, and Clavius (see the article cited at the beginning) brings forward Bede as more clearly explaining a statement of Ambrose to the same effect. Now Ambrose mentions no such thing; and meeting with the statement of Jerome since we wrote that article, we are inclined to suppose that Clavius meant to have quoted one of the contemporary saints, and wrote down a citation from the other,—a supposition which would explain what must otherwise be called a disingenuous proceeding. Hence comes the current story that Eusebius and others were appointed by the council a committee to superintend the drawing up of the rule.

Shortly after the Nicene Council there were disputes about the proper cycle for Easter. It is unnecessary here to note the various cycles which were proposed. It was not till the time of Pope Hilarius (A.D. 463) that the cycle of nineteen years obtained a permanent footing. The pontiff employed Victorinus of Aquitaine to correct the calendar; and Victorinus actually constructed the cycle of 532 years, or of 28 Metonic cycles. When Dionysius Exiguus (A.D. 530) altered the mode of reckoning, and abandoned the Diocletian era in favour of what he supposed to be the year of the birth of Christ, he adjusted the mode of reckoning employed by Victorinus accordingly, and the cycle of the latter has ever since been called Dionysian. From his time till that of the Gregorian reformation the rule was strictly observed, no disapprobation producing anything but written arguments. So that the Nicene Council neither succeeded, nor, we assert, intended to succeed, in doing more than destroying, among the great bulk of Christians, what was called the *quartadeciman* heresy, the opinion that Easter was to be kept on the fourteenth day of the moon,—the opinion, in fact, that Easter was *the Passover*. The settlement of the arithmetical or astronomical question is the work of Hilarius and Victorinus. Not but that these reformers considered themselves as fulfilling the intentions of the Nicene Council: in fact, all parties after the council made it their authority. All dissentients assumed theirs to be the Nicene faith in this matter; and even the blunder of the British Parliament has been defended by supposing it to be the true intent of the assembled bishops in the 4th century.

The assumption of the so-called Dionysian cycle involved two errors. The Julian year being too long by about a day in 130 years, threw the vernal equinox back by a day in that time; while the rule of the cycle supposed that the equinox remained fixed on the 21st of March. Again, the cycle of nineteen years, which supposes 235 lunations to fill up that time exactly, was wrong in a manner which caused the new moons of the calendar to advance a day in every 300 years. The consequence was, that by the time of Pope Gregory XIII., in 1582, the equinox had receded to the 11th of March, while the calendar new moon generally fell on the fourth day following that of the real new moon. These errors were obvious enough to every astronomer. Sacrobosco and Roger Bacon pointed them out in the 13th century. The former says they must be borne on the authority of the council; the latter strongly recommended Pope Clement to make an amendment, and gave a reformed plan which is perfectly good. He had (and where he got it from we cannot guess) the length of the year more correctly than any of his predecessors or contemporaries. Cardinal Cusa and Regiomontanus, in the 15th century, pointed out the necessity of a change. Stöffler, Pitatus (who proposed the plan afterwards adopted with the leap years), Paulus Forosemproniensis (bishop of Fossombrone), and others in the 16th century, wrote in advocacy of the same thing. The Council of Trent sanctioned an alteration, and referred the details to the see of Rome. A plan was presented to the pope by the relatives of one Aloysius Lilius, deceased, who had occupied himself with the subject. This plan was approved of; and in 1577 a circular was forwarded to princes and universities throughout the Catholic world, stating the nature of the intended alterations, and inviting suggestions. The Jesuit Clavius was the person, or the principal person, to whom the concoction of the scheme was intrusted. March 1, 1582, a bull was published, dated February 24th, 1581, abolishing the old calendar, giving a general description of the new one, and announcing that it would be fully explained in a forthcoming work. Clavius published this work, namely, 'Kalendarium Gregorianum Perpetuum,' 4to, Rome, 1582 (pp. 60); and it was reprinted in the folio collection of his works. We have nothing here to do with the alteration of the style, but only with what relates to Easter. This calendar had to undergo several severe attacks, particularly from Joseph Scaliger, Moestlinus, and Vieta [Vieta, in Biog. Div.]; but these, of course, produced no effect against established authority, nor, in truth, ought they to have done so in this instance. The calendar answers its purpose exceedingly well, and is, astronomically speaking, better than it was supposed to be by Clavius himself.

Referring for a full description of the details to the article in the 'Companion to the Almanac,' we shall give a slighter account of the process. Clavius held astronomical considerations to be secondary in importance to the general notions of his predecessors and contemporaries. One of these was, that it was not desirable ever to keep Easter on the same day as the Jews keep the Passover. To avoid this, he uniformly lessens the moon's age by a day, taking care, as much as possible, that all the necessary errors of the imperfect cycle shall have the same effect, namely, that of lessening the moon's age, or throwing the new moons forward. Accordingly, his new moons are seldom on the real day, generally one or two days in advance, about as much of one as of the other, and sometimes even three days in advance. It is therefore very important to remember that the moon of the calendar is not the moon of the heavens, and not even the mean moon of the astronomers. So that in the act of parliament, instead of the full moon (being the fifteenth or sixteenth day) of the heavens (the first day being that of new moon), should have been read the fourteenth day of the moon of the calendar. There is evidently a compensating effect; the fourteenth day of a moon, which begins for the most part one or two days after the moon of the heavens, is of course generally the fifteenth or sixteenth day of the moon of the heavens.

Clavius uses the Dionysian cycle in a way which we may describe as follows:—Neglecting the preceding arbitrary alteration, which may be made once for all when everything else is done, there are two things to be provided for. First, the defect of the cycle itself, the error of which is to advance the new and full moons by a day in about 300 years; Clavius took it to be eight days in 2500 years, and accordingly he allowed one day for seven periods of 300 years, and then one day for a period of 400 years, as we shall presently see. Next, the abandonment of three leap-years in every four centuries, which, though necessary for keeping the equinox at or about one day of one month, would destroy the efficiency of the cycle of nineteen years. There are then two shiftings, as it were, of the cycle necessary—arbitrary alterations of the moon's age at certain periods (we are now speaking only of the calendar moon). We shall now give a set of cycles, resembling the one already given, which is that of our own time, from which we shall be able to make the shifts apparent, and to connect them with the above-mentioned necessary corrections. Tables of this form were not given by Clavius himself, but were published in England, we believe by Lord Macclesfield, at the time of the discussions preceding the alteration of the style in 1752.

In the first column are the days of the month, from March 21 to April 25, and Easter may fall on any one of these days except the first. In the second column are the dominical letters, explained in DOMINICAL LETTER, and which can be found by the table there given. In leap-year, take the second letter of the year in finding Easter. Then follow certain columns, each of which has a heading to show to what years it belongs. Thus, the column headed 1700–1899 belongs to all years from 1700 to 1899, both inclusive. These columns contain the nineteen golden numbers variously dispersed. Every year has its golden number found thus: add 1 to the year and divide by 19; the remainder, or 19, if there be no remainder, is the golden number.

		1583–1699.	1700–1899.	1900–2199.	2200–2299.	2300–2399.	2400–2499.	2500–2599.	2600–2899.
March 21	C	3	14	..	6	17	6	17	..
,, 22	D	..	3	14	..	6	..	6	17
,, 23	E	11	..	3	14	..	14	..	6
,, 24	F	..	11	..	3	14	3	14	..
,, 25	G	19	..	11	..	3	..	3	14
,, 26	A	8	19	..	11	..	11	..	3
,, 27	B	..	8	19	..	11	..	11	..
,, 28	C	16	..	8	19	..	19	..	11
,, 29	D	5	16	..	8	19	8	19	..
,, 30	E	..	5	16	..	8	..	8	19
,, 31	F	13	..	5	16	..	16	..	8
April 1	G	2	13	..	5	16	5	16	..
,, 2	A	..	2	13	..	5	..	5	16
,, 3	B	10	..	2	13	..	13	..	5
,, 4	C	..	10	..	2	13	2	13	..
,, 5	D	18	..	10	..	2	..	2	13
,, 6	E	7	18	..	10	..	10	..	2
,, 7	F	..	7	18	..	10	..	10	..
,, 8	G	15	..	7	18	..	18	..	10
,, 9	A	4	15	..	7	18	7	18	..
,, 10	B	..	4	15	..	7	..	7	18
,, 11	C	12	..	4	15	..	15	..	7
,, 12	D	1	12	..	4	15	4	15	..
,, 13	E	..	1	12	..	4	..	4	15
,, 14	F	9	..	1	12	..	12	..	4
,, 15	G	..	9	..	1	12	1	12	..
,, 16	A	17	..	9	..	1	..	1	12
,, 17	B	6	17	17	9	..	9	..	1
,, 18	C	14	6	6	17	9	17	9	9
,, 19	D	..	..	..	..	..	..	..	..
,, 20	E	..	..	..	..	..	..	..	..
,, 21	F	..	..	..	..	..	..	..	..
,, 22	G	..	..	..	..	..	..	..	..
,, 23	A	..	..	..	..	..	..	..	..
,, 24	B	..	..	..	..	..	..	..	..
,, 25	C	..	..	..	..	..	..	..	..

Take the first of these columns, namely, 1583–1699. Opposite to April 8 is written the number 15. This means that, from 1583 to 1699, whenever the golden number is 15, the fourteenth day of the calendar moon is the 8th of April. And so in like manner throughout these columns each golden number is written opposite the day which is the fourteenth of the calendar moon when that golden number occurs. Thus from 2600 to 2899, the fourteenth of the paschal (calendar) moon is always on the 2nd of April whenever the golden number is 16.

Let us now suppose the first column constructed. It is contrived, as before noticed, so as to make the calendar full moons follow the real ones. To keep this up, whatever alterations must be made in a cycle adapted to the real moon, the same must be made for the calendar moon. As far as 1699 no alteration is requisite, for Clavius does not make the first alteration on account of the incorrectness of the cycle till 1800, and the year 1600 is leap-year in the Gregorian calendar as well as in the old one. The reader must remember that the cycle of 19 years is one in which every fourth year is leap-year. As soon as 1700 comes, we have a fourth year which is not leap-year, so that the day which would have been called February 29 is called March 1, and so on. Each golden number then is written one place lower from 1700 to 1899; though it would better have represented the reason of the change if each day of the month had been written one place higher. The same thing takes place at 1800; but here Clavius puts the moon back a day, or makes his calendar moon a day older, to correct the accumulated error of the cycle. But the previous step makes the calendar moon, at any given day, a nominal day younger than it would otherwise have been. These two changes destroy each other's effect in 1800, and the cycle continues unaltered till 1899. At 1900 the first change is repeated; but 2000 *is* leap-year in the new calendar, and therefore no change is then requisite. And again, though 2100 is not leap-year, yet as 300 years have elapsed, the correction for the fault of the cycle is introduced at the same time with that for the abandoned leap-year, and the two destroy each other's effects, as before. This column then is good till 2199. The next column is now easily explained: but in the next one to that, or 2400–2499, we begin with a year in which the correction for the cycle is to be made without being destroyed by that arising from abandoning leap-year. That is, the moon, on any given day, is to be a day older than it would otherwise have been. The numbers must then each be put back a day, which is seen to be done. In this manner, if it be remembered that, beginning at 1800, seven following corrections of the cycle are made at the end of periods of 300 years each, and then one at the end of 400 years—the reader would be able to construct farther cycles for himself, if it were not for one peculiarity which we now notice.

At the bottom of the columns it will be seen that there are in one or two places numbers which do not rise or fall with the rest. This was a sacrifice of uniformity to the desire of preserving one characteristic of the old calendar, namely, that the fourteenth of the calendar moon never fell on the same day of the same month at any two epochs which were within nineteen years of each other. This would have happened sometimes, owing to the corrections above described: and Clavius took a very simple method of avoiding it, which is explained in the article already cited. The effect of his method is to produce the slight departure from uniformity of alteration above noted.

It will thus be seen that in the calendar which is now in use, one, two, or even three days of error have not (provided the moon was made too young, not too old) been thought of so much consequence as either ease of calculation, or attention to existing notions upon the subject. Of this we entirely approve, and agree with Clavius in asserting that any rule which is fixed would be better than diversity of usage.

To find Easter by the preceding table, first find the golden number, and then the dominical letter. [DOMINICAL LETTER.] Take the proper column, and find out the day opposite to which the golden number stands. Go on from that day to the next *following* day which has the dominical letter opposite to it: that day is Easter Sunday. For example, take 1847. Add one, and divide by 19; the remainder is 5, the golden number. The dominical letter found in the article cited is C. In the column 1700–1899, we find 5 opposite to March 30, which is the fourteenth of the calendar moon. The next C is opposite April 4, which is Easter Sunday.

Again, to find Easter in 2384. Divide 2385 by 19, and the remainder is 10, the golden number. The dominical letter (the second) is G. In the column 2300–2399 the 10 is opposite to April 7, and the next G is opposite to April 8, which is Easter Sunday.

The dominical letter may be found by a short calculation as follows:—

I. Add one to the given year.

II. Take the quotient of the given year, divided by four, neglecting the remainder.

III. Take 16 from the centurial figures of the given year, if it can be done.

IV. Divide III. by 4, neglecting the remainder.

V. From the sum of I., II., and IV., subtract III.

VI. The remainder of V., after division by 7, is the number under dominical letter in

G	F	E	D	C	B	A
0	1	2	3	4	5	6

But if the year be leap-year, it is the second dominical letter which is thus found.

As instances, take 1847 and 2384, as above given.

I.	1848	2385
II.	461	596
III.	2	7
IV.	0	1
V.	2307	2975
VI.	4 (C)	0 (G)

The above is for new style; for old style proceed as follows: To the number of the year add its quotient when divided by 4, and 4: the remainder, after division by 7, is to be used as the VI. of the preceding rule. Thus for 1583, we have

1583
395
4
7)1982
283 Rem. 1. Dominical Letter F

The cycle for Easter-day, old style, is given at the beginning.

The sole authority on the subject of the Gregorian Calendar is, of course, Clavius, the authorised contriver of it, or at least the person to whom the other delegates of the Roman see (if indeed any of them took any share in the execution of the plan) intrusted the explanation of it. In his work already mentioned, he has given all the results for every year from 1600 to 5000: he thinks his rule will be correct enough as far as 8000. On the mathematical part of the calendar full information will be found in Delambre's 'Histoire de l'Astronomie Moderne,' and Lalande's 'Astronomy.'

With regard to the faulty explanation in the act of parliament, we find that it was copied literally from the Book of Common Prayer. In this work it appeared for the first time in 1662, directly after the convocation which met at the Restoration of the monarchy had made the alterations mentioned in LITURGY. The explanation was therefore added by this convocation. Supposing the calendar moon to be spoken of, it would have been correct if the second clause had been omitted. For the calendar full moon is always the fifteenth day, and it is clear that "the Sunday after the fourteenth, or the next Sunday if the fourteenth fall on Sunday," is the same thing as "the Sunday after the fifteenth, or the fifteenth itself, if it be Sunday." Finding definitions of Easter by the fifteenth, in the second of the two ways just mentioned, to have occurred in times anterior to the Restoration, we suppose that the explanation of 1662 was the result of a confusion of the two.

EASTER DUES. [OFFERINGS.]

EAVES. [HOUSES.]

EBB. [TIDES.]

EBIONITES, a sect of Christian Jews, which existed in Palestine and other parts of the East in the 1st and 2nd centuries of our era. Like the Nazarenes, with whom they have been often confounded, they continued to observe the precepts and ceremonies of the Mosaic law; they kept both the Sabbath and the Sunday, made their ablutions, used unleavened bread in the celebration of the Eucharist, and, moreover, abstained from eating flesh. Still they do not seem to have formed a distinct sect till after the second destruction of Jerusalem by Hadrian, when they became separated from the rest of the Church by their dogmas as well as by their external practices. Origen, Epiphanius, Eusebius, and other early fathers, distinguish two sorts of Ebionites, —namely, those who denied the divinity of Jesus Christ, asserting that he was the son of Joseph and Mary, though endowed with a prophetic gift; and those who maintained that he was born of a virgin, but denied his pre-existence as God. The Ebionites in general acknowledged only one gospel, namely, the Hebrew one, which goes by the name of St. Matthew, and that one mutilated. They discarded the Acts of the Apostles, and especially the Epistles of St. Paul, whom they considered as an apostate from the old law. They had several apocryphal books; among others, a life of St. Peter. The earlier Ebionites lived a regular life, and many of them observed celibacy, which they held in great esteem. The later Ebionites became much more lax in their morals. The name of Ebionites is said by Eusebius, Origen, and Irenæus, to be derived from a Hebrew word of contempt, meaning "poor low people," which the Jews applied to those of their countrymen who had embraced Christianity. Others have derived it from a philosopher of the name of Ebion, whose existence however is doubtful. Epiphanius speaks at length of the Ebionites, but he confounds them with other sects, and his account cannot be trusted. The Ebionites never rose into much importance, and exercised but little influence on the spread of Christianity. (Mosheim, *Institutes of Eccles. History*, with *notes* by Dr. Murdoch; Neander, *Kirchengeschichte*.)

EBULLITION (*ebullio*, to boil). Under BOILING OF LIQUIDS were given the chemical and physical aspects of ebullition. Under the present head we propose to notice what is called the *spheroidal state of liquids*, which has of late years attracted considerable attention.

In 1756 Leidenfrost called attention to the fact that, when water is allowed to fall upon a red-hot iron plate, it does not boil, but forms into drops, which roll or jump about for a considerable time. This experiment has attracted the attention at various times of such men as Klaproth, Count Rumford, Pouillet, and Dumas; and it came to be shown as a class experiment, in which case a small platinum crucible is strongly heated by means of a copious flame from the spirit-lamp, and water is dropped into it from a pipette: the water does not boil, but the drops coalesce and roll about with considerable activity. In this way about one-fourth or one-third of the crucible may be filled; and, provided the heat be well maintained, the water does not only not boil, but evaporates very slowly. If, however, the heat be withdrawn, the water remains quiet for about half a minute, and then suddenly bursts into steam and disappears. In 1837, Mr. Tomlinson ('Mechanics' Magazine,' No. 703) showed that other liquids might be substituted for water in the above experiment, such as pyroxilic spirit, spirits of wine, sulphuric ether, and even mercury; but the last is quickly dissipated. Such fluids as come into immediate contact with the hot metal, such as oil of turpentine, olive oil, and sulphuric acid, were immediately decomposed and failed to produce the effect. The same writer ('Students' Manual of Natural Philosophy,' 1838) also showed that many saline solutions could be used instead of water; but the most curious result obtained by him was the use of a hot liquid surface instead of a metallic one, such as a fixed oil, raised to the temperature of 450° or 500°. Some care is required in this experiment: the liquid, such as water, alcohol, or ether, must be delivered from a pipette, with a steady hand, directly on to the surface of the hot oil; not allowed to fall, otherwise the liquid may sink under the surface, generate steam with explosive violence, and scatter about the hot oil. If, while a globule of water be rotating on the hot oil, a globule of ether be also placed on it the two drops will coalesce and continue to rotate as one globule the ether forming the outer surface of the drop. Turpentine forms a disc on the hot oil, and quickly disappears by evaporation; but pyroxilic spirit and bisulphide of carbon form globules. Sulphuric ether also forms a globule on the surface of hot water and hot mercury. Sulphuric acid heated to about 400° may also be used as the heated surface for ether and alcohol; but turpentine and naphtha form discs which quickly blacken the acid. Mr. Tomlinson refers to an experiment by Perkins, in which a platinum capsule, pierced with a multitude of holes like a coffee-strainer, which would not of course hold water while cold, retained it when strongly heated in consequence of water assuming the spheroidal state.

The physicists who had examined this phenomenon were pretty well agreed that the water, when in the globular or spheroidal state, was below its boiling point. Of this there could, of course, be no doubt; but what the exact temperature was had not been determined, any more than why the liquids, in the midst of so high a temperature, should be so little influenced by it. Rumford supposed it to be due "to the reflection of caloric operating on the surface of the drops of water." Pouillet supposes that "the calorific rays emanating from the vessel traverse the water too easily when they are very hot." Dumas ('Chimie Appliquée aux Arts,' i. 32), while admitting the fact, thinks "it ought to caution us against the accidents which a steam-boiler is liable to produce, when raised accidentally to a high temperature; for it might happen that it ceases to furnish steam, and, nevertheless, a reduction of temperature would cause an explosion. Plates of fusible metal are especially useful in 'preventing accidents' of this kind, since they limit the temperature that can be attained by the boiler; for it is evident that a valve would not be raised at the moment when this singular phenomenon should display itself."

In 1845-6 M. Boutigny exhibited some remarkable experiments on this subject before the British Association, and in several institutions of the metropolis; among others, in the laboratory of King's College, where the writer had an opportunity of seeing them. The most remarkable effect was the freezing of water in a red- or white-hot crucible, for which purpose advantage was taken of the low boiling-point (that is, 140° Fahr.) of liquid sulphurous acid. This assumes the spheroidal state a little below 14°; and if water be dropped into the crucible, it immediately falls considerably below its freezing-point, and a lump of solid ice can be turned out of the glowing vessel into the hand. Faraday has even carried the matter further, by freezing mercury under similar circumstances, substituting for the sulphurous acid a solution of solid carbonic acid in ether. By means of this mixture, a degree of cold has been obtained equal to about —166°; and as mercury freezes at —39°, we can understand how the mixture will assume the spheroidal state in the red-hot crucible, and mercury be readily frozen. Boutigny also placed iodine on an ignited platinum capsule, when it melted, formed a spheroidal black-looking mass, which rolled about and gave off but little vapour. But when the source of heat was withdrawn, an abundant evolution of violet-coloured fumes took place. A thick cylinder of silver was heated to redness, and lowered by means of a wire into a glass of water, where it quietly remained for a considerable time. But perhaps the most remarkable result was the impunity with which M. Boutigny passed his hand backwards and forwards through a stream of cast iron as it issued from the furnace, thus showing that the old ordeal by fire was not so formidable a trial as would at first sight appear. The above phenomena admit of explanation: First, on the fact that, whenever the liquids are thrown upon strongly-heated surfaces, a portion of the liquid is immediately converted into vapour, upon which the globule rests as on a cushion. Now as this vapour is a bad conductor of heat, it shields the globule from the conducting powers of the heated surface. In the second place, the evaporation from the surface of the globule carries off the heat as fast as it arrives, and thus maintains the globule at a temperature below that of its boiling-point. The spheroidal form of the drop is a joint effect of gravity and cohesion among the fluid particles. There must also be taken into account the repulsive force exerted by heat under the circumstances. So necessary is the condition that the liquid in the spheroidal state shall be below boiling, that if a liquid actually in the state of ebullition be introduced into the red-hot crucible, its temperature sinks from 5° to 7° below its boiling-point.

According to Boutigny, all liquids are capable of assuming this state; but in all cases the heated surface must bear a certain relation to the boiling-point of the liquid: if the latter be low, the former must be comparatively low also. The required temperature depends partly on the conducting power of the plate, and partly on the latent heat of the vapour: as this is small, the heat of the plate may approximate more nearly to the boiling-point of the liquid. The lowest heat of the plate required to throw water into the spheroidal state is said to be 340° Fahr.; alcohol, 273°; ether, 142°. The temperature of each liquid in the spheroidal state is supposed to be as definite as its boiling-point. Boutigny gives 205·7° Fahr. as the temperature of the spheroidal state of water, 167·9° for that of alcohol, 93·6° for that of ether, and 13·1° for that of sulphurous acid. The spheroidal state may be produced in vacuo. In the experiment in which the moist hand is made to cut a stream of molten iron, the moisture of the hand forms the cushion of steam which prevents the metal from coming in contact with the skin.

An ingenious application of the spheroidal condition of liquids is sometimes made in the glass-house in blowing globes or cylinders of large size: the globular form is first given by means of open hemispherical wooden moulds; and, to prevent them from being burnt, the workman pours into them a small quantity of water, which protects the wood, and, assuming the spheroidal state, does not cool the molten glass.

ECBALIUM OFFICINARUM, (Richard), is the name now given to the plant, the unripe fruit of which furnishes the *elaterium* of the Materia Medica. Its familiar name is Wild Cucumber, or Asses' Cucumber, indicative of its appearance, and hurtful properties to those who incautiously employ it. Its medical or professional employment will generally be sufficiently careful—but as its incautious handling even may lead to serious, if not fatal effects, it is proper that these should be guarded against. The exhalation from the fruit, which can readily be absorbed through the human skin, is capable of producing as strong effects as a dose of the substance taken by the mouth. An instance is recorded where a small portion of the plant, with only one or two small fruits on it, carried in the hat for not more than an hour, produced violent headache, vomiting, and purging, followed by a degree of exhausting depression, almost fatal.

The other points connected with this plant are treated of under MORMODICA in the NAT. HIST. DIV., and under ELATERIN, in ARTS AND SCI. DIV.

ECCENTRIC IN MACHINERY. [EXCENTRIC.]

ECCLESIASTES, or THE PREACHER, a canonical book of the Old Testament, placed after the Proverbs and before the Song of Solomon. The English title is adopted from that in the Greek Septuagint (Ἐκκλησιαστής, *Ecclesiastes*), which is a translation of the Hebrew title קהלת, *Koheleth*, that is, one who calls together or calls out to an assembly—a public declaimer or preacher. A review of the various learned interpretations of this term is given in Mr. Holden's work on Ecclesiastes, p. 31. Widely different opinions have been expressed by many Biblical critics concerning the author, date, and design of this portion of the Bible. The general supposition that Ecclesiastes was written by Solomon is apparently warranted by the passages i. 1, 12, 16, ii. 4–9, which designate the author as the son of David, king of Israel, and the greatest possessor of wealth and wisdom in Jerusalem. The writers of the Talmud, and Rabbi Kimchi attribute this book, as well as Proverbs and the Song, to King Hezekiah or the prophet Isaiah. The Rev. G. Holden, in his 'Attempt to Illustrate the Book of Ecclesiastes,' ably contends for its authorship by Solomon, in his old age, when he had repented of his former practices, and says, "Many parts of the work itself corroborate this opinion. The acknowledgment of numerous follies and delusions implies that it was composed after the author had apostatised from Jehovah, and had subsequently repented of his past misconduct." This view seems by far the best supported by the internal evidence of the book; notwithstanding the opposition founded on style, and certain asserted minute inconsistencies by many German, French, and English authors. Dr. Adam Clarke ('Preface to Ecclesiastes,' in his ed. of the Bible) asserts that the traditionary notion entertained by the Jews and many Christian divines, as Jerome, Huet, Michaelis, &c., that Ecclesiastes was written by Solomon in his old age, after recovering from idolatry and sensuality, is an assumption which never has been nor can be proved to be true; for since it was "when Solomon was *old*, that his heart was turned away after other gods by his 700 wives and 300 concubines" (1 Kings, ii. 3 and 4); and as he died about the age of sixty, the supposition of a final period of philosophical and pious contrition is not warranted by probability. "The language," says the same divine, "puzzles me not a little; Chaldaisms, Syriasms, and Chaldee words are frequent, and the style is that of the authors who lived at or after the captivity." Bishop Lowth remarks that the style is peculiar; the diction low, exceedingly obscure, loose, unconnected, and resembling conversation. ('Prælect.' 24.) The general opinion of the commentators, that the design of the book is to inquire about the *supreme good*, and to show that it consists in religious wisdom, is adopted by Mr. Holden, with the idea, also, of its consisting of two divisions: the first, to verse 10 of chap. vi., being occupied in setting forth the vanity of all the labours and enjoyments of human life; the second, in eulogising religious wisdom and describing its nature and effects. This wisdom has nothing sensual; it is holy and spiritual; and forms the ultimate good for creatures who are to be responsible for their actions. The book was included in the canon of the Hebrew Scriptures alluded to and sanctioned by our Saviour in Luke xxiv. 44, and by St. Paul in 2 Timothy iii. 16.

ECCLESIASTICAL COMMISSIONERS. The Ecclesiastical Commissioners are a body corporate, created by the statute 6 & 7 Will. IV. c. 77, for certain purposes and with certain powers therein named. The great inequalities in the extent and income of the dioceses of England and Wales, in the duties and receipts of the cathedral and collegiate bodies, and in the extent of parishes and the annual value of the benefices of the Church of England, after long and angry comments, gave rise in 1835 to the issue of two commissions, directing the persons named therein to consider the state of the dioceses with reference to the amount of their revenues, and the more equal distribution of episcopal duties; and of the several cathedral and collegiate churches, with a view to the suggestion of such measures as might render them conducive to the efficiency of the Established Church; and further, to devise the best mode of providing for the cure of souls with special reference to the residence of the clergy on their respective benefices. These commissioners made four reports, recommending various alterations, and the appointment of permanent commissioners, for the purpose of preparing and laying before the sovereign in council such schemes as should appear to them to be best adapted for carrying those recommendations into effect; the Crown being empowered to make orders ratifying such schemes, having the full force of law. The statute above mentioned was passed in consequence; and under its provisions a great many beneficial alterations have been and are being effected. The recommendations contained in the four reports of the original commissioners have also been carried out, with certain modifications and amendments, to which the sanction of Parliament was required and obtained (see 1 & 2 Vict. cc. 30, 106, 108; 2 & 3 Vict. cc. 9, 14; 3 & 4 Vict. c. 113; 4 & 5 Vict. c. 39; 6 & 7 Vict. c. 77; 10 & 11 Vict. cc. 98, 108; 13 & 14 Vict. c. 41; 16 & 17 Vict. c. 50). The chief features of the alterations thus effected are the equalisation of the territorial extent of the dioceses, the creation of the new sees of Ripon and Manchester, and the union of the sees of Gloucester and Bristol. The revenues of the sees have also been equalised, by augmenting the income of the smaller out of the revenues of the larger. Cathedral and collegiate bodies have also been regulated. The powers and constitution of the Ecclesiastical Commissioners have been amended by the stat. 3 & 4 Vict. c. 113, s. 78: and by the appointment of Church Estates Commissioners, who are *ex officio* members of the Ecclesiastical Commission (13 & 14 Vict. c. 94; 14 & 15 Vict. c. 104; 19 & 20 Vict. c. 74); and, lastly, by the transfer to them of the powers of the Church-Building Commissioners.

ECCLESIASTICAL COURTS. Tribunals in which the archbishops and bishops exercise jurisdiction over matters within their control. Long previous to the Conquest, during the reigns of the Danish and Saxon kings, the bishops and clergy held synods or councils. (See Sir H. Spelman, Wilkins' 'Concilia,' Johnstone's 'Canons and Constitutions.') The bishops also assisted as counsellors in the national Witten-gamotte (the antetype of our parliament), and assisted in common with the shire-reeves, or sheriffs, in the administration of justice. Shortly after the Conquest, William promulgated a charter, whereby he severed civil and ecclesiastical jurisdiction, thereby creating for the latter a distinct and independent authority, and a law was passed to the effect that no bishop should take cognisance of secular matters, and that no lay tribunal should take cognisance of matters affecting the clergy or relating to the church. Hence may be traced the origin of the present several ecclesiastical courts throughout the land, and their independent jurisdiction has from time to time been confirmed by canons, emanating it is true from ecclesiastical authority, but applied by legislative enactment, sometimes restraining their power, at others confirming and enlarging it. (For example, see 13 Edw. I. st. 4, c. 1; 9 Edw. I. st. 1, c. 1; 50 Edw. III. c. 4; 2 & 3 Edw. VI. c. 13; and Coke's 'Inst.,' 663.)

It was the policy of the early English monarchy to foster the power of the church as a check to that of the barons or nobles of the land, who struggled to interpose the principles of the feudal law as a barrier to regal assumption. But the sovereign found that the ecclesiastical authority, culminating as it did in the Pope of Rome, he being the ultimate appellee, interfered with, if it did not usurp, his function of government, in as much as it declared the clergy amenable to the ecclesiastical authority alone, be their offence what it might; and thus Henry II. caused to be framed, as a check, the 'Constitutions of Clarendon,' whereby the clergy were made amenable to the secular power in secular matters. But the ecclesiastical courts still retained full power to adjudicate upon all matters affecting the clergy in their peculiar vocation, and also upon all spiritual matters affecting the laity (which, in their language, concerned the health of the soul). And thus, even after the Reformation, numbers of persons, even in Protestant times, were sent to the dungeon and the faggot for heresy or unsound doctrine, by these tribunals, from which there was no appeal, and where ofttimes prejudice and zeal usurped the province of justice.

As far back as July, 1830, a Commission was appointed to inquire into the practice and jurisdiction of the ecclesiastical courts in England and Wales. The report of the Commissioners, which was presented in 1831, was signed by the archbishop of Canterbury, and three of the bishops, the two chief justices, the chief baron, and several other persons of authority and eminence. This report gives the most correct and authentic account which exists of—1. The nature of the ecclesiastical courts; 2. Of the course of proceeding in ecclesiastical suits; and 3. The nature of the processes, practice, and pleadings of the ecclesiastical courts. Other commissions were appointed by the Crown, and bills have been brought into Parliament from time to time; and in consequence a great change has at length been effected with regard to the jurisdiction of the ecclesiastical courts: they no longer can take cognisance of testamentary causes, nor do they any longer retain the right to grant probate of a will or letters of administration. The act of Parliament, 20 & 21 Vict. c. 77, which came into operation on the 11th of January, 1858, has transferred the voluntary and contentious jurisdiction in relation to the granting or revoking wills and letters of administration to a newly constituted court, called the "Court of Probate," its functions to be exercised in the name of the Sovereign, in such place as the

Sovereign in council shall from time to time appoint. At present the court sits in Westminster Hall. So also by the 20 & 21 Vict. c. 85, are they deprived of their jurisdiction over questions of marriage and divorce. The power of granting judicial separations (similar to those *à mensâ et thoro*, but more remedial in their effect) is now vested in the crown, as also the power of dissolving a marriage. [DIVORCE.] The court styled Her Majesty's Court for Divorce and Matrimonial Causes alone administers matrimonial law, subject to an appeal to the House of Lords. The archbishops and bishops, however, still retain their privilege of granting licenses to marry without publication of banns.

By these enactments the ecclesiastical courts have lost the most important of their functions, but they still retain exclusive cognisance of all spiritual matters concerning the clergy, such as the preaching or publishing of unsound doctrine, that is, anything repugnant to the articles or doctrine of the Church of England; and also their discipline, that is, their moral conduct and mode of life; also whether the performance of the church service is at variance with the injunctions of the rubric. (The Church Discipline Act, 3 & 4 Vict., c. 86, defines and regulates the mode of procedure against offending clergymen, although its provisions are by no means perfect in attaining its object). They also can inquire into the refusal of a bishop to institute the presentee of a patron to a living by the form of a proceeding known as a *duplex querela*; non-payment of church-rates, repair of churches and faculties for their alteration, the extension and violation of graveyards, or the removal of bodies; the right to pews, whether merely a possessory right or one confirmed by title or presumption; brawling, that is, violent behaviour in the church; non-payment of tithes (where there is no modus or prescription, in which case the matter is for the temporal courts); simony, also a matter for temporal cognisance, as regards a layman. These are questions within the jurisdiction of the ecclesiastical courts, to which might be added incontinence, swearing, drunkenness, absence from church, and other matters which, in former times, it was deemed the duty of Mother Church to restrain and punish; but such proceedings have fallen into desuetude.

The ordinary ecclesiastical courts are: 1. The *Provincial Courts*, being, in the province of Canterbury, the Court of Arches, or Supreme Court of Appeal, the jurisdiction of which is settled by 23 Hen. VIII. c. 9, and the Court of Peculiars; and in the province of York, the Chancery Court. 2. The *Diocesan Courts*, being the consistorial court of each bishop, exercising general jurisdiction; the court or courts of one or more commissaries appointed by the bishop, or fixed by custom, in certain dioceses, to exercise general jurisdiction, within prescribed limits; and the court or courts of one or more archdeacons or their officials, who exercise general or limited jurisdiction, according to the terms of their patents, or to local custom. 3. There are also *Peculiars* of various descriptions in most dioceses, and in some they are very numerous: royal, archiepiscopal, episcopal, decanal, sub-decanal, prebendal, rectorial, and vicarial.

The Provincial Courts of the archbishop of Canterbury, and the archbishop of York, are independent of each other; the process of one province does not run into the other, but is sent by a requisition from the court of one province to the local authority of the other, for execution, when it is necessary. The appeal from each of the provincial courts lies to the sovereign, represented by the Judicial Committee of Privy Council; but before the passing of the statute 2 & 3 Will. IV., c. 92, a commission issued under the Great Seal in each individual case of appeal, to certain persons or delegates, to hear and determine the matter in contest. [DELEGATES, COURT OF.]

Of the three Archiepiscopal Courts of Canterbury, the Arches Court is the first [ARCHES, COURT OF,] (deriving its title from the place where it originally sat, Bow Church, *St. Mary de arcubus*). It is presided over by a functionary, styled the "Dean of the Arches," appointed by the archbishop of Canterbury. This court exercises appellate jurisdiction from each of the diocesan and most of the peculiar courts within the province. It may also take original cognisance of causes by letters of request, from each of those courts.

The Court of Peculiars, thirteen of which are in the Province of Canterbury, is the third Archiepiscopal Court of Canterbury, it takes cognisance of all matters arising in those Peculiars, among which are the Deaneries of London, Rochester, and Winchester; and some others, over which the archbishop exercises ordinary jurisdiction, and which are exempt from and independent of the several bishops within whose dioceses they are locally situated.

The province of Canterbury includes twenty-one dioceses. The Archbishop's Court (that is, the Arches Court), does not exercise ordinary episcopal jurisdiction, and therefore a commissary is appointed for that purpose, which stands on the same footing as the ordinary consistory of a bishop. Thus the ordinary episcopal jurisdiction is exercised by the commissary, in the same manner as in other dioceses.

The province of York includes five dioceses, besides that of Sodor and Man, the archiepiscopal jurisdiction is exercised therein much in the same manner as in the province of Canterbury.

The Diocesan Courts take cognisance of all matters arising locally within their respective limits, with the exception of places subject to peculiar jurisdiction. They may decide matters of spiritual discipline; suspend clergymen from their office, and administer the other branches of ecclesiastical law; but in matters of importance the case is generally sent to the Arches Court by letters of request.

The Archdeacon's Court is generally subordinate, with an appeal to the Bishop's Court; though in some instances it is independent and co-ordinate.

The Archdeacons' Courts, and the various Peculiars already enumerated, in some instances take cognisance of all the ecclesiastical matters arising within their own limits, though the jurisdiction of many of the peculiar courts extends only to a single parish: the authority of some of them is limited to a part only of the matters that are usually the subject of ecclesiastical cognisance; several of the peculiars possess voluntary but not contentious jurisdiction.

The total number of courts which exercise any species of ecclesiastical jurisdiction in England and Wales is 372, which may be classed as follows:—

Provincial and diocesan courts	36
Courts of bishops' commissaries	14
Archidiaconal courts	87
Peculiar Jurisdictions.	
Royal	11
Archiepiscopal and episcopal	44
Decanal, subdecanal, &c.	44
Prebendal	88
Rectorial and vicarial	63
Other peculiars	17
Courts of lords of manors	48

The amount of compensation awarded to the judges, registrars, and other officials of the several courts abolished by the late Acts, taking the half of an average of fees, &c. for the five years preceding 11th January, 1858, amounted, for England to 40,950*l.* 14*s.* 8*d.*, and to the proctors 60,304*l.* 9*s.* 9*d*; for Ireland, judges, &c., 7719*l.* 9*s.* 8*d.*; proctors, 8717*l.* 18*s.* 2*d.*, making in the whole 117,782*l.* 12*s.* 8*d.*, payable in the shape of annuities.

The canon law has been practised in the ecclesiastical courts as a distinct profession for upwards of three centuries; but owing to recent changes by taking from those courts their testamentary and matrimonial jurisdiction, it is scarcely probable that any body of professional men will henceforth devote themselves exclusively to those tribunals. The courts, together with that of the Admiralty, have hitherto sate in the College of Advocates at Doctors' Commons, where also, in close contiguity to the court, have resided the judges and advocates. The site of the building was purchased by some members of this body in 1567. [DOCTORS' COMMONS.] The members of the society were incorporated in 1768 by a royal charter, under the name of 'The College of Doctors of Laws exercent in the Ecclesiastical and Admiralty Courts.' The proctors discharge duties similar to those of solicitors and attorneys in other courts. [PROCTOR.]

The course of proceeding in these courts is as follows:—The mode of commencing the suit, and bringing the parties before the court, is by a process called a Citation, or summons. This citation, in ordinary cases, is obtained as a matter of course, from the registry of the court, and under its seal; but in special cases, the facts are alleged in what is termed an act of court, and upon those facts the judge or his surrogate decrees the party to be cited; to which, in certain cases, is added an intimation, that if the party does not appear, or appearing does not show cause to the contrary, the prayer of the plaintiff, set forth in the decree, will be granted. The party cited may either appear in person, or by his proctor, who is appointed by an instrument, under hand and seal, termed a proxy. The proctor thus appointed represents the party, acts for him and manages the cause, and binds him by his acts.

The mode of enforcing all processes, in case of disobedience, is by pronouncing the party cited to be contumacious; and if the disobedience continues, a significavit issues, upon which an attachment from Chancery is obtained, to imprison the party till he obeys. In cases where some act is required to be done by the party cited, the compulsory process is enforced; but in some cases, where no act is necessary to be done by the party cited, the plaintiff may proceed in pœnam contumaciæ, and the cause then goes on *ex parte*, as if the defendant had appeared. The party cited, to save his contumacy, may appear under protest, and may show cause against being cited; such as, that the court has no jurisdiction in the subject-matter, or that he is not amenable to that jurisdiction: this preliminary objection is heard upon petition and affidavits; and either the protest is allowed, and the defendant is dismissed, or the protest is overruled, and the defendant is assigned to appear absolutely; and costs are generally given against the unsuccessful party. Each party may appeal from the decision on this preliminary point; or the defendant, in case the judge decides against him on the question of jurisdiction, and on some other questions, may apply to a court of law for a prohibition.

The form of the pleadings is next to be described. These are intended to contain a statement of the facts relied upon and proposed to be proved by each party in the suit, the real grounds of the action, and of the defence.

Causes, in their quality, are technically classed and described as plenary and summary, though in modern practice there is substantially little difference in the mode of proceeding. All causes in the Prerogative Court are summary.

The first plea bears different names in the different descriptions of causes. In criminal proceedings, the first plea is termed the Articles; in form, it runs in the name of the judge, who articles and objects the facts charged against the defendant; in plenary causes, not criminal, the first plea is termed the Libel, and runs in the name of the party or his proctor, who alleges and propounds the facts founding the demand. Every subsequent plea, in all causes, whether reponsive or rejoining, and by whatever party given, is termed an Allegation.

Each of these pleas contains a statement of the facts upon which the party founds his demand for relief, or his defence; they resemble the bill and answer in equity, the allegation is divided into separate positions or articles: the facts are alleged under separate heads, according to the subject-matter, or the order of time in which they have occurred. Under this form of pleading the witnesses are produced and examined only to particular articles of the allegation, which contain the facts within their knowledge in private by an appointed examiner of the court; their evidence is taken down and produced on the hearing; a notice or designation of the witnesses is delivered to the adverse party, who is thereby distinctly apprised of the points to which he should address his cross-examination of each witness, as well as the matters which it may be necessary for him to contradict or explain by counter-pleading.

Before a plea of any kind, whether articles, libel, or allegation, is admitted, it is open to the adverse party to object to its admission, either in the whole or in part: in the whole, when the facts altogether, if taken to be true, will not entitle the party giving the plea to the demand which he makes, or to support the defence which he sets up; in part, if any of the facts pleaded are irrelevant to the matter in issue, or could not be proved by admissible evidence, or are incapable of proof. These objections are made and argued before the judge, and decided upon by him, but his decision may be appealed from. For the purpose of the argument, all the facts capable of proof are assumed to be true; they are however so assumed merely for the argument, but are not so admitted in the cause; for the party who offers the plea is no less bound afterwards to prove the facts, and the party who objects to the plea is no less at liberty afterwards to contradict the facts. If the plea is admitted, the further opposition may be withdrawn: if the plea is rejected, the party who offers it either abandons the suit, or appeals against the rejection, in order to take the judgment of a superior tribunal. When a plea has been admitted, a time, or term probatory, is assigned to the party who gives the plea, to examine his witnesses; and the adverse party is assigned, except in criminal matters, to give in his answers upon oath, to his knowledge or belief of the facts alleged. The defendant may proceed then, if he thinks proper, or he may wait until the plaintiff has examined his witnesses, to give an allegation controverting his adversary's plea. This responsive allegation is proceeded upon in the same manner; objections to its admissibility may be taken, answers upon oath be required, and witnesses examined. The plaintiff may, in like manner, reply by a further allegation; and on that, or any subsequent allegation, the same course is pursued.

In taking evidence, the witnesses are either brought to London to be examined, or they are examined by a commission near their places of residence. Their attendance is required by a Compulsory, somewhat in the nature of a subpœna, obedience to which is enforced in the same way as in other cases of contumacy. The examination is by depositions taken in writing and in private by examiners of the court, employed for that purpose by the registrars. The examination does not take place upon written interrogatories previously prepared and known; but the allegation is delivered to the examiner, who, after making himself master of all the facts pleaded, examines the witnesses by questions which he frames at the time, so as to obtain, upon each article of the allegation separately, the truth and the whole truth, as far as he possibly can, respecting such of the circumstances alleged as are within the knowledge of each witness. The cross-examination is conducted by interrogatories addressed to the adverse witnesses, and when the deposition is complete, the witness is examined upon the interrogatories delivered to the examiner by the adverse proctor, but not disclosed to the witness till after the examination in chief is concluded and signed, nor to the party producing him till publication passes; and each witness is enjoined not to disclose the interrogatories, nor any part of his evidence, till after publication. In order that the party addressing the interrogatories may be the better prepared, the proctor producing the witness delivers, as before stated, a designation, or notice of the articles of the plea on which it is intended to examine each witness produced.

The examination and cross-examination of witnesses are kept secret until publication passes; that is, until copies of the depositions may be had by the adverse parties, after which either party is allowed to except to the credit of any witness, upon matter contained in his deposition. The exception must be confined to such matter, and not made to general character, for that must be pleaded before publication; nor can the exception refer to matter before pleaded, for that should be contradicted also before publication. The exception must also tend to show that the witness has deposed falsely and corruptly. The exceptive allegations are proceeded upon, when admitted, in the same manner as other pleas. They are not frequently offered, and are always received with great caution and strictness, as they tend more commonly to protract the suit and to increase expense than to afford substantial information in the cause. It is, however, in the power of the court to allow further pleading by way of additional articles; and if new circumstances of importance are unexpectedly brought out by the interrogatories, the court will, in the exercise of its discretion, allow a further plea after publication. This may also be permitted in cases where facts have either occurred or come to the knowledge of the party, subsequently to publication having passed.

The evidence on both sides being published, the cause is set down for hearing. All the papers, the pleas, exhibits (or written papers proved in the cause), interrogatories, and depositions, are delivered to the judge for perusal before the case is argued by counsel. All causes are heard publicly in open court; and as in other courts, the counsel state their respective cases. The evidence is then read, unless the judge signifies that he has already read it, and even then particular parts are read again if necessary. The judgment of the court is then pronounced upon the law and facts of the case; and in doing this, the judge publicly, in open court, assigns the reasons for his decisions, stating the principles and authorities on which he decides the matters of law, and reciting or adverting to the various parts of the evidence from which he deduces his conclusions of fact, and thus the matter in controversy between the parties becomes adjudged.

The execution of the sentence, in case there be no appeal interposed, is either completed by the court itself, according to the nature of the case, and execution is enforced by the process of contumacy, significavit, and attachment; but this can only be done by calling in the aid of the Court of Chancery. Ecclesiastical courts, not being courts of record, have no power to commit of their own authority. The question of costs in these courts is, for the most part, a matter in the discretion of the judge, according to the nature and justice of the case; and the reasons for granting or refusing costs are publicly expressed at the time of giving the judgment.

Attempts were made more than three centuries ago to remedy the defects of the ecclesiastical courts. The earliest efforts of this kind were directed to the peculiar jurisdictions. Some of these jurisdictions extend over large tracts of country, and embrace many towns and parishes; others comprehend several places lying at a great distance from each other; and some only include one or two parishes. The jurisdiction to be exercised in these courts is not defined by any general law, and it is often difficult to ascertain to what description of cases the jurisdiction of any particular court extends. The commissioners appointed to revise the ecclesiastical laws, in the reigns of Henry VIII. and Edward VI., recommended that the power of the bishop, in matters of discipline, should extend to all places in the diocese, notwithstanding the exemptions and privileges of Peculiars. In the reign of Queen Elizabeth, it was proposed or talked of in convocation that parliament should be applied to, to subject peculiar and exempt rights and jurisdictions of what had belonged to monasteries to the diocesan. Nothing, however, appears to have been done until, in 1857, the 20 & 21 Vict. c. 77, and c. 85, were passed, directing the sweeping changes before named. For full information on the constitution and practice of these courts, see the report of the Ecclesiastical Commissioners published in 1832, and Coote's 'Ecclesiastical Practice.'

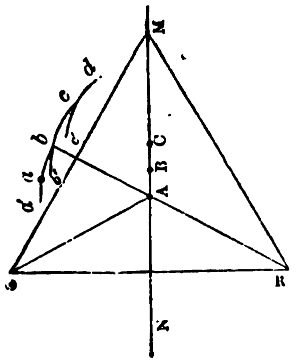
ECCLESIA'STICUS, or THE WISDOM OF JESUS THE SON OF SIRAC, an apocryphal book of the Old Testament. It is stated to have been originally written in Syro-Chaldaic, by Jesus, the son of Sirac, a learned Jew, who travelled in pursuit of knowledge 130 years B.C. It was translated into Greek for the use of the Jews of Alexandria, by the grandson of the author, or rather compiler, for it is evidently a collection of fragments, written at different times and on various occasions, consisting of meditations and proverbs relating to religion, morals, and the general conduct of human life. But though it is manifest that no methodical plan or arrangement was observed in the composition, the commentators remark that the whole will admit of division into three parts. The first extends to the end of chap. 43, and is occupied in the commendation of wisdom and the statement of moral precepts. The second celebrates the virtues of the patriarchs and prophets of the Jews, and extends to the end of chap. 49. The third part is comprised in the 50th and concluding chapter, and consists of a prayer or hymn, exhorting mankind to the pursuit of wisdom. These meditations display much acuteness of thought, with propriety of diction, and occasionally poetical eloquence. They closely resemble the numerous other oriental proverbs, and especially the collection attributed to Solomon. In the western Christian church this book was highly esteemed; the council of Carthage made it canonical, as the fifth book of Solomon, and the council of Trent confirmed the decision. It was also introduced by the early Protestant reformers into the liturgy of the church of England.

Addison, in the 68th number of the Spectator, observes, that were this collection issued under the name of Confucius, or one of the sages of Greece, it would be regarded as one of the most brilliant moral treatises ever published. The opinion which attributes it to Solomon is falsified by several allusions to the captivity, showing that some parts at least were written under the monarchs of Babylon (c. 47, &c.), 400 years subsequent to the reign of Solomon. The Greek fathers frequently cite the book of Ecclesiasticus as ἡ Ἰησοῦ Σοφία, the Wisdom of Jesus; Πανάρετος Σοφία, the Excellent Wisdom; and Λόγος, the Rational Discourse. The Latin fathers named it Ecclesiasticus, or the Book of the Church, from its being then appointed to be read in churches. A Syriac and an Arabic version are extant. The Latin version, which is supposed to be of the first century, contains numerous words adopted from the Greek, but differs much from the present Greek text.

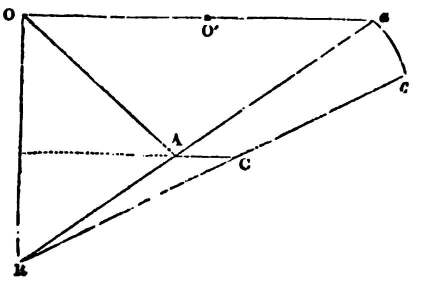
(*Ecclesiasticus, or the Book of the Church,* by Luke Howard, F.R.S., 1827; Dalrymple, Lord Hailes, *Wisdom of Solomon, or Ecclesiasticus,* 1755; Sonntag, *Comment. de Jesu Siracidæ Ecclesiastico,* 4to., 1792; Bretschneider, *de lib. Jesu Siracidæ* (prolegom. pp. 10–32), dates the original compilation 180 B.C.; Horne's *Introduct to the Bible,* vol. iv.)

E'CHEVIN, the name given under the old French monarchy to the municipal magistrates of various cities and towns. At Paris there were four échevins and a prévôt des marchands, whose jurisdiction extended over the town and adjacent territory; in the other towns there was a maire and two or more échevins. In the south of France the same officers were called by other names, such as consuls in Languedoc and Dauphine, capitouls at Toulouse, jurats at Bordeaux. The last name, that of jurats, is retained in some of the English municipalities. They tried minor suits, laid the local duties or octroi upon imports, had the inspection of the commercial revenues and expenditure, as well as the superintendence of the streets, roads, and markets, the repairs of public buildings, &c. The name échevins seems to have been derived from scabini, a Latin word of the middle ages, which was used in Italy under the Longobards, and in France, Flanders, and other countries under the Carlovingian dynasty. In Holland they are called schepens. The scabini were the assessors to the counts or missi dominici, appointed by the monarch to administer a province or district; and they were chosen among the local inhabitants. Afterwards, when charters were given to the communes, the municipal magistrates elected by the burgesses assumed also the name of scabini or échevins. (Ducange, 'Glossarium.')

ECHO. (ἠχὼ, ἦχος, *sound*). When sonorous undulations are propagated from any origin through the elastic medium of the air, the spherical wave-like surface then conveys the sound through the circumjacent space, and moves from its origin and centre with a velocity of about 1125 feet in a second, at the ordinary atmospheric pressure and temperature; for the velocity of undulations propagated through elastic media depends only on their indices of elasticity and not on their intensity. [ACOUSTICS.]



Suppose the point O to be the origin of a sound which in its progress encounters a plane obstacle NM; if this plane be sufficiently extended, a point M may be easily found which the sound will have just reached at the end of a given time. The waves which have previously reached the nearer points A, B, C, being precluded from advancing, are there reflected according to the usual law of reflection of light, that is, new spherical undulations *a'ab, b'bc, c'cd* are generated from A, B, C as centres, and their radii at the moment we have spoken of are respectively $\mathrm{A}b = \mathrm{OM} - \mathrm{OA}$, $\mathrm{B}c = \mathrm{OM} - \mathrm{OB}$, $\mathrm{C}d = \mathrm{OM} - \mathrm{OC}$, and it is easily seen that all these spherical surfaces originating from A up to M and existing simultaneously, may be exactly enveloped by a single portion of a spherical surface of which the centre is placed in a position R corresponding to O in respect to its distance from NM, but at the opposite side of the obstacle; this spherical surface, of which the radius is RM, is the true returning wave at that moment, and



being impressed on the auditory organs, so as to be distinguished from the original sound, is called the *echo.*

When a sound originates at a point O, and is reflected by a plane obstacle AC, the reflected pulsation of the air occupies the space of a conical frustum *a*AC*c*, the vertex of the cone R being situated symmetrically with O at the opposite side of AC. In order that a person may hear the echo of his own sounds, it is therefore necessary that his situation may be a point O' in a perpendicular to AC; and that a second person may hear the echo of the voice of another at O, he must be situated in the frustum *a*AC*c*, so that the angles of incidence and reflection of the sound which reaches his ear may be equal, as in the case of the reflection of light, and the impact of perfectly elastic bodies [LIGHT; COLLISION]; in both cases the distance from AC must be sufficiently great to distinguish between the original and the reflected sound.

The echo of a continued sound or note may be heard in the inverse order of time to that in which it was generated, provided the origin of the sound moves more rapidly towards the hearer than the rate at which sound travels. Thus a flash of lightning moving towards a person will produce a roll of thunder which, echoed by clouds, will be heard as it were backwards; but if the direction of the flash be such that the points of its course are nearly equidistant from the auditor, an instantaneous and intensely loud clap will be substituted for a continued roll.

The murmuring sound produced by the discharge of great guns is the succession of echoes from the particles of vapour floating in the atmosphere, and when the discharge is effected under a dense cloud, the echoes are stronger and better reflected, and a noise resembling a thunder-roll may then be heard. The whizzing of a bullet is attributed to its impinging in a state of rapid rotation on particles of vapour.

The time intervening between the primitive sound and its echo has sometimes been employed in determining the distance from the observer to the reflecting object, allowing 571 feet for each intermediate second of time; but like all methods dependent more on individual judgment than mechanical measurement, this process must be liable to considerable irregularities.

When several objects reflect sound, the number of echoes is greatly multiplied, not only from the primary echoes of each, but also from secondary and tertiary echoes by second and third reflections of returning waves against the reverberatory obstacles; each re-echo consists of only portions or frusta of the preceding; their intensities therefore diminish, and they gradually die away upon the ear, in the same manner that the images become obscure and by degrees imperceptible in consequence of the diminution of light when we look between two opposite and parallel plane mirrors. The reflecting plane, however, must be at a great distance in order to produce polysyllabic echoes. At Woodstock is one repeating from seventeen to twenty syllables, and the Swiss mountaineers sing their *Ranz des Vaches,* so that the echoes form an accompaniment to the tune itself.

The first echo heard in such circumstances is by no means necessarily the loudest. Taking any ellipse of which one focus is the origin of the sound and the other the place of the auditor, it is a well-known property of this curve that right lines drawn from the foci to any point in it make equal angles with the tangent at that point. Conceive now this ellipse to rotate round the line joining the foci so as to form a prolate spheroid, then sound emanating from one focus and reflected by a portion of the surface will be directed after reflection to the other, and its intensity will depend on the solid angle subtended at the focus by the reflecting body. Each echoing body may be conceived as a portion of such a spheroidal surface, taking a large axis major to comprehend the more distant bodies; and since the sum of the solid angles subtended by the more distant reflectors may be greater than those given by the nearer, the echo produced by them, though not reaching the ear so soon as that of the nearer, may, under such circumstances, be louder. We must, however, bear in mind in our estimate that this intensity has a source of diminution in the increase of distance. This case frequently occurs in places encompassed by chains of mountains, as at Killarney and the Welsh lakes, &c.

When the succession of echoes from several bodies is sufficiently rapid, a continued sound or note may be produced, though the original sound was merely momentary; and when not sufficiently rapid for this purpose, a clamorous noise is produced, and hence Echo with her thousand tongues and babbling propensities has furnished matter for poetic imagination from Ovid to Shakspere. Hence, Echo has been called the "shadow of a sound," "a voice without a mouth, and words without a tongue." Echo too, though represented as a female, never speaks until she is spoken to, and at every repetition of what she has heard, continues to make it less, an example recommended to the special imitation of scandal-mongers. As a single *ha!* may be converted into an imitation of a stunning laugh, the romantic and echoing regions inhabited by the Scandinavian races materially assisted their untutored imaginations in attributing this appalling music to the aërial revelries of invisible hags or witches. The blow of a hammer against one side of a parallel fissure in a rock, sometimes produces echoes sufficiently rapid in succession to give the tone of a bell, as in the Bell-rock at Tonbridge-wells.

But when, as in the case of the electric fluid, the original cause of sound may be said to exist simultaneously through an extensive tract of an excited atmosphere, a sound perfectly continuous and majestic is produced in the thunder-roll, which may frequently be heard again echoed by neighbouring clouds, or awfully prolonged by repeated reflections from an amphitheatre of mountains.

A similar effect of rapidly repeated echoes may be perceived in the prolonged tread and ringing sounds which we hear when walking in stillness through long galleries, cloisters, and other narrow passages with parallel sides, particularly when the air is confined; but hangings and carpetings, yielding to the impulse of the sonorous waves, or stifling them by a multitude of interior reflections, together with open windows or much furniture, diminish these effects to a great extent.

The distribution of sound in public edifices, so that the echoes may be most advantageously brought to strengthen the original sound, is a subject practically deserving of much attention. For some sensible observations on the errors of architects in this respect, we must refer to Sir J. Herschel's treatise on 'Sound.' Certainly the unlucky error of placing the confessional in the cathedral of Girgenti in a focus conjugate to another, which happened to be an unenclosed part of the church, by which Echo was instrumental in informing a husband of the infidelity of his spouse; and the parabolic reflector of a late ingenious clergyman at Cambridge, which had the effect of completely stunning him, however impartially his voice was distributed to his congregation, are not inconveniences of such common occurrence as those contrivances by which a part of an audience in a church or theatre possesses a monopoly, while the remainder witness the ceremony or performance in dumb show.

A ludicrous anecdote, mentioned by Lord Bacon, of a Frenchman calling out Satan, and being answered *Va-t'en*, led him to assert that the letter S was not echoed, and this assertion has been copied by several authors. The fact is, that S being in a great measure a breathing, the distance necessary for the production of a distinct echo is too great to render it audible, owing to its small intensity; but when its echo is taken at a small distance, the effect is to increase the sound, and this disagreeable prolongation is very perceptible in churches whenever persons in repeating the service make use of this letter. The whispering gallery of St. Paul's is another instance of this error, for a low whisper uttered at one end is conveyed by successive reflections along its curved roof, and being again concentrated at the other end, may be distinctly heard, although, in such cases, it has been also attributed, not to *reflection*, but to what Mr. Scott Russell terms *lateral accumulation*, of the sonorous wave.

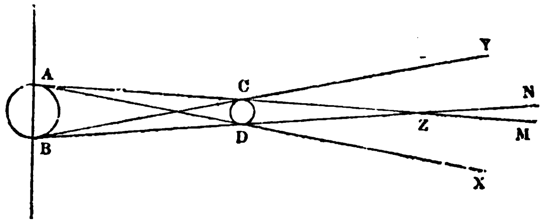
When the reflecting surfaces, instead of plane, are curved, as in caverns, grottoes, rocks, or ruined buildings, the reflected sound will be most intense at the foci, or the points which would be most enlightened *by reflection* if a luminous body were substituted in the place of the original source of sound.

Whatever may be the figure of the echoing surface, the total path traversed by a wave in a given time before and after reflection taken together is constant (and, when the time varies, is proportional to it); therefore a small portion of a plane section of the echoing surface is common also to an ellipse having one focus at the origin of sound, the other in the returning wave, and the axis major equal to the space traversed by sound in a given time. Hence, *first*, the plane sections of the returning wave are the loci of the second foci of a series of ellipses, having a common focus and equal axes major, all touching the section of the echoing surface; and, *secondly*, the figure of an obstacle necessary to produce a given wave will be found by taking the curve which touches a series of ellipses having their second foci in this wave surface and their first focus and axis major as before: this should, however, strictly speaking, be confined to surfaces of revolution.

Lastly, M. Colladon has found from his experiments, that if sonorous undulations excited within a fluid impinge very obliquely on its surface, they do not emerge, but are *internally* reflected, as in the case of light, forming thus an echo within the fluid.

ECLECTICS. The name given to those philosophers who, without adopting any particular system, or dogmatising for themselves, professed to select (ἐκλέγειν) from other philosophical systems whatever they conceived most conformable to truth, and fitted those detached parts together so as to form a new whole. The notion of such a union of jarring systems seems first to have originated with the Neoplatonists, who endeavoured to settle the dispute between themselves and the Peripatetics, by the adoption of such parts of the doctrine of Aristotle as could be made to tally with their modification of the academic philosophy. This union of the Aristotelian and Platonic philosophies was attempted first by Potamo of Alexandria, whose principles were taken up and maintained by Ammonius Saccas. It may be doubted, however, if the title of Eclectics can be properly given to Potamo or Ammonius, the former of whom was in fact merely a Neoplatonist, and the latter rather jumbled together the different systems of Greek philosophy (with the exception of that of Epicurus), than selected the consistent parts of all of them. The most eminent of the followers of Ammonius were Plotinus, Porphyry, Jamblichus, Proclus, and Clemens Alexandrinus; and the ancient Eclecticism became at last little more than an attempt to reconcile Platonism with Christianity. The modern and more genuine school of Eclecticism sprung up in the 17th century, when Bacon and Descartes flourished. These philosophers, refusing to acknowledge themselves members of any particular sect, or to adopt any principle on the mere authority of their predecessors, formed systems for themselves which admitted the doctrines of any other sect without distinction, whenever those doctrines were not at variance with what their own investigation had taught them of the nature of things. But modern philosophers have since then formed themselves into new sects, and a new Eclecticism has consequently arisen in our own days, of which the originator was Hegel, and the most eminent supporter Victor Cousin; this newest Eclecticism resembles that of the Alexandrian Platonists in being rather a union of systems than a selection from them.

ECLIPSE (*ecleipsis*, ἔκλειψις), an astronomical phenomenon, being the disappearance of a heavenly body. This may happen in two distinct ways; either the disappearing body may be lost on account of another body coming between it and its source of light, and thus intercepting the light; or the disappearance of a body may be caused by another body coming between it and the spectator. These two sets of circumstances, though ending in the same species of phenomenon, are yet of a character so different that it will be advisable to consider the two in separate articles. We shall therefore here content ourselves with an enumeration of the various kinds of eclipses; leaving further detail, when necessary, to the articles which will be referred to.



Let us suppose a spherical body A B, which is luminous, and another, C D, the smaller of the two, which is not luminous. Let us consider first the circular sections of these bodies made by the plane of the paper, and let common tangents be drawn to these sections, four in number, namely, A X, B Y, A M, and B N. If the bodies be very distant from each other, in comparison with their bulk, then it will be sufficient for practical purposes to consider these common tangents as intersecting at A and B and C and D, the opposite extremities of two parallel diameters. If the whole figure then revolve round the line joining the centre of the two circles, the spherical bodies will be reproduced, together with the conical envelopes by which it may be seen on what the phases of an eclipse depend.

The whole space generated by the revolution of Y C D X is, in whole or in part, deprived of the light from A B. Within the space C D Z (or the cone generated by its revolution), the loss of light is total: a spectator situated within that cone sees no part of A B, and a planet which receives its light from A B cannot, when in that cone, be visible in any part of space. This is even true at the point Z; but anywhere within the cone N Z M, more or less of the border of A B is visible, and C D hides a portion of the middle of A B. If C D be small in comparison with A B, then the effect of C D to a spectator situated far off in N Z M is only the appearance of a small dark spot upon the face of A B.

Within the spaces Y C Z N and M Z D X, a part only of the face of A B is hidden from a spectator there situated, and part only of the light of A B is lost. On the lines C Y or D X the spectator imagines the two bodies A B and C D to be in contact.

The eclipses in which the disappearance takes place by the removal of the light from the body are—

1. The eclipse of the moon. [Lunar Eclipse.]
2. The disappearance of a portion of Jupiter's surface, occasioned by one of its satellites passing between it and the sun. This is usually called the transit of the satellite's shadow over the disc of Jupiter. [Jupiter.]
3. The eclipses of Jupiter's satellites. [Jupiter.]

The eclipses in which the disappearance arises from the absolute interposition of another planet are—

1. The eclipse of the sun [Solar Eclipse], meaning the eclipse of the sun by the moon.
2. The eclipse of the sun (that is, of a very small portion of the sun) by Mercury or by Venus, commonly called the *transit* of Mercury or Venus over the sun's disc. [Mercury, Transit of; Venus, Transit of.]
3. The occultation of a fixed star by the moon. [Moon.]
4. The eclipse of a portion of Jupiter by one of its own satellites, or transit of a satellite over the disc. [Jupiter.]
5. The eclipse of a satellite of Jupiter by Jupiter itself, or occultation of a satellite by the planet. [Jupiter.]

We have here mentioned such eclipses as are not unfrequent: the only additional phenomenon which we are aware of is the eclipse of a portion of the ring of Saturn by a satellite, or passage of a satellite over the ring, seen by Sir W. Herschel. The satellites of Saturn must suffer eclipses of the first kind by entering the shadows either of the planet or the ring, and of the second kind both from the planet and the ring; but these satellites are only seen with very good telescopes and under very favourable circumstances, so that their eclipses excite little public curiosity. For an account of the physical phenomena observed during eclipses of the sun and moon, see the articles, Solar Eclipse, and Lunar Eclipse.

ECLIPTIC. [Equator and Ecliptic.]

ECLOGUE. [Bucolics].

ECONOMISTS. [Political Economy.]

EDDA. [Scandinavian Mythology.]

EDDY is a circular motion of the water, either in rivers or in the sea. It exists more frequently in rivers between the proper current and the counter current; the edges of one current brushing against another giving to a small portion of the water a circular motion. But an eddy is also produced when the current, running with some violence against a rock or elevated shore, is driven back and meets in the bed of the river or on the opposite shore another obstacle to its course. In this case the eddy generally occupies the greatest part of the bed of the river, and is frequently called a *whirlpool*. Eddies occur in the sea likewise, where two currents run parallel, but in different directions, as between the Equatorial and North African current. Whirlpools also occur frequently among rocky islands near a coast. [Whirlpool.]

EDGE. [Arris.]

EDICTAL LAW. The English Equity has some resemblance to the Roman Edictal law, or Jus Prætorium or Honorarium, as it is often called. All the higher Roman magistrates (*magistratus majores*) had the *jus edicendi* or authority to promulgate edicta. These *magistratus majores* were consuls, prætors, curule ædiles, and censors. By virtue of this power a magistrate made edicta or orders, either temporary and for particular occasions (*edicta repentina*); or upon entering on his office he promulgated rules or orders, which he would observe in the exercise of his office (*edicta perpetua*). These edicta were written on a white tablet (*album*) in black letters; the headings or titles were in red. The alba were placed in the Forum, in such a position that they could be read by a stander-by ("ubi de plano recte legi posset," D. 2, 1, 7). Those edicta which related to the administration of justice had an important effect on the Roman law, and especially the Prætoria Edicta, and those of the Curule Ædiles. That branch of law which was founded on the Prætorian Edicta was designated Jus Prætorium or Honorarium, because the prætor held one of those offices to which the term Honores was applied. The edicta were only in force during the term of office of the magistratus who promulgated them; but his successor adopted many or all of his predecessor's edicta, and hence arose the expression of "transferred edicts" (*tralaticia edicta*); and thus in the later republic the edicta which had been long established began to exercise a great influence on the law, and particularly on the forms of procedure. About the time of Cicero many distinguished jurists began to write treatises on the edictum (*libri ad edictum*). Under the emperors new edicta were rarer, and in the 3rd century of our æra they ceased. Under the empire we first find the edicta of the Præfectus Urbi mentioned; but these must be considered as founded on the imperial authority (*majestas principis*), and to have resembled the imperial constitutions. (See Tacit. Ann., 6, 11; Suet. Aug., 37; Dio. Cass., 52, 21; and Dig. i. 12, and i. 28.) Under the reign of Hadrian a compilation was made by his authority of the edictal rules by the distinguished jurist Salvius Julianus, in conjunction with Servius Cornelius, which is spoken of under the name of Edictum Perpetuum. This edictum was arranged under various heads or titles, such as those relating to marriage, tutores, legata (legacies), and so on.

By the term Prætorian Edict the Romans meant the edicts of the Prætor Urbanus, who was the chief personage employed in the higher administration of justice under the republic. The edicta which related to Peregrini (aliens) were so named after the Prætor Peregrinus; and other edicta were called Censoria, Consularia, Ædilicia, and so on. Sometimes an edict of importance took its name from the prætor who promulgated it, as Carbonianum Edictum. Sometimes the Honorariæ actiones, those which the prætor or ædile by his edict permitted, and which Ulpian opposes to Actiones Civiles, just as we oppose legal to equitable remedies (D. 44, 7, 25, 2), were named in like manner from the magistrate who introduced them. Sometimes an edict had its name from the matter to which it referred. The Romans generally cited the edicta by parts, titles, chapters, or clauses of the Edictum Perpetuum by naming the initial words, as Unde Legitimi, and so on. Sometimes they are cited by a reference to their contents. Examples of these modes of citing the edictum occur in the titles of the 43rd book of the 'Digest.' (See the title 'Quorum Bonorum.') In our own law we refer to certain forms of proceedings and to certain actions in a like way, as when we say *quo warranto, quare impedit*, and speak of *qui tam* actions.

The Jus Prætorium is defined by Papinian ('Dig.' i. tit. i. 7) as the law which the prætors introduced for the purpose of aiding, supplying, or correcting the law (*jus civile*), with a view to the public interest. The edict is called by Marcianus "the living voice of the Jus Civile," that is, of the 'Common' law. ('Dig.' i. tit. i. 8.) The Prætorian law as thus formed (*jus prætorium*), was a body of law which was distinguished by this name from the Jus Civile, or the strict law; the opposition resembled that of the English terms equity and law. In its complete and large sense, Jus Civile Romanorum, or the law of the Romans, of course comprehended the Jus Prætorium; but in its narrower sense Jus Civile was contrasted, as already explained, with the Jus Prætorium.

The origin of the Roman edictal law is plainly to be traced to the imperfections of the old Jus Civile, and to the necessity of gradually modifying law and procedure according to the changing circumstances of the times. It was by the prætors and the prætorian courts that the improvements in the Roman law were worked out after long years of labour, by a skilful adaptation of new forms to old processes, by an equally skilful use of fictions, and especially by means of the interdictal remedies. Nor was it because it was an easier method of doing this than by direct legislation that the prætors strove to improve the law in this way, but because they were under the imperious necessity of observing that reverence for old forms and old customs which is one of the most striking characteristics of the old Roman people, and which is nowhere more visible than in the history of their jurisprudence. (See on this point, the influence of the prætors upon Roman law, Dr. Abdy's 'Historical Sketch of Civil Procedure among the Romans,' chapter ii.) Numerous modern treatises contain a view of the origin and nature of the Roman Jus Prætorium, though on some points there is not complete uniformity of opinion.

(Bocking, *Institutionen*, vol. i.; Puchta, *Cursus der Institutionen*, vol. i., p. 293; Savigny, *Geschichte des Röm. Rechts*, vol. i.; Heffter, *Die Oeconomie des Edictes, Rhein. Mus. für Juris.*, i., p. 51; E. Schrader, *Die Prätorischen Edicte der Römer*, 1815.)

EDICTS, EDICTA, one of the five sources of Roman law enumerated by Gaius (i. § 2). "The magistrates of the Roman people have authority to make edicts; but the greatest weight is given to the edicts of the two prætors, the Prætor Urbanus and the Prætor Peregrinus. In the provinces, the governors (præsides) have the same authority as the prætors (in the city). The authority of the curule ædiles, as to making edicts, is the same as that of the prætors, and in the provinces their powers are possessed by the quæstors." (On the Edict. Ædil. see 'Dig.,' xxi. tit. 1; and on the Ædilian Actions, 'Cod.' iv. tit. 58.)

It was the custom of the prætors on their accession to office to publish edicts, which were rules published for the benefit of suitors, and for the express purpose of regulating the practice of their courts during their year of office. This power of regulating the practice of their courts having been abused, especially by the custom of altering their original edict during their year of office, it was enacted by the Cornelian law, passed about A.U.C. 685, that when a prætor, on his accession to office, had published any edict or general rule, he should be bound to keep to it during the whole year of his office. After the adoption of this law, the prætors, though by no means bounded in the limits of their jurisdiction, were certainly tied down more strictly to the observance of the *litera scripta* of their edicts, and were not only obliged to submit to these edicts and to judge according to their provisions, but were responsible to the tribunes in the discharge of their functions. A prætor was not bound by the edicts of his predecessor; if he confirmed them, the edicts were called Vetera et Tralatitia; if he made new edicts, they were called Nova. On an occasion mentioned by Cicero ('De Offic.,' iii. 20) the prætors and tribunes of the Plebs united in drawing up a penal edict (edictum cum pœnâ et judicio) relative to the coinage. This instance will serve as an example of the extent to which the prætors under the republic exercised legislative power. Instead of confining themselves to rules for the regulation of the practice of the courts, they gradually assumed the power of repealing written law and making new laws, on the ground of correcting the error of the written laws whenever they seemed inapplicable from generality or other defect. But, as M. Schrader has shown, it was not by opposing the old laws,—objects of reverence to the Roman people,—but by bringing them into accordance with the necessities of the times and the changing manners of the people, that reforms in the law were intoduced by the Prætors. (See on this subject Abdy's 'Civil Procedure among the Romans,' chapter ii.; Hugo's 'History of the Roman Law;' and W. Smith's edition of Gibbon's 'Decline and Fall,' vol. v., p. 266.) From the decisions of the prætors arose a large body of law, whoh was known by the name of Jus Honorarium or Prætorium (Papinian. 'Dig.' i., tit. 1, 7), as distinguished from the Jus Civile, and may to a certain extent be considered as corresponding to the English courts of equity.

Under the early emperors the magistrates published edicts, but Hadrian commissioned Salvius Julianus (A.D. 132) to make a digest of all the best decisions, which were collected in a small volume called the Edictum Perpetuum, and ratified by a Senatus Consultum. From that time the power of making edicts was taken from the magistrates, and the legislative power was vested in the emperors. ('Cod.' i. tit. 17.) [Constitution, Roman.]

EDUCATION. [Schools.]

EDULCORATION. The operation of washing a finely divided solid with water, or other liquid, in which the solid is nearly or quite insoluble. It is chiefly employed in chemical analysis to separate soluble matters from insoluble precipitates. [Chemical Analysis.]

EFFENDI is a Turkish word, which signifies "Master, Monsieur," and is subjoined as a title of respect to the names of persons, especially to those of learned men and ecclesiastics; for example, *Omar Effendi*, *Ahmed Effendi*, in the same manner in which *Agha* is placed after the names of military and court officers, and is nearly equivalent to "Sir." The word Effendi occurs also as part of some titles of particular officers, as *Reis Effendi*, the former title of the principal secretary of state, and prime minister of the Ottoman empire, which was properly an abbreviation of *Reis-al-Kettáb*, that is, "the head or chief of secretaries or writers."

EFFERVESCENCE. The escape of bubbles of gas from a liquid. The phenomenon is seen when marble or chalk is dropped into vinegar, or when the cork of a soda-water or champagne bottle is removed.

EFFLORESCENCE (from *effloresco*, to blow as a flower). A term applied to the formation of small crystals on the surface of bodies, in consequence of the abstraction of moisture from them by the atmosphere. Thus carbonate of soda and sulphate of soda, when exposed to the air, part with their water of crystallisation, and crumble down, or *effloresce*, to a white powder. Other salts on the contrary, such as carbonate of potash and chloride of calcium, absorb moisture from the air and become damp, or even liquefy in the water so absorbed. This is called *deliquescence* (from *deliqueo*, to melt), and the salts are called *deliquescent*, as in the former case they are termed *efflorescent*.

EFFUSION. A term nearly related to DIFFUSION, and has reference to the velocities with which different gases pass through the same small aperture into a vacuum. These velocities are stated by Professor Graham ('Phil. Trans.' 1846) to be inversely as the square roots of the densities of the gases. The lightest gas enters the most rapidly, and any change in the density of the gas has but little influence on the rate of effusion, the volume effused in a given time being nearly uniform. The same law also applies to liquids in passing through an aperture in a thin plate. In the case of gases, Graham made use of an aperture of about $\frac{1}{500}$th of an inch in diameter. In the following table the numbers in the third column represent the rates of effusion of different gases obtained experimentally, and it will be seen that they coincide within the limits of experimental errors, with the relative rates of diffusion of the respective gases.

Gases.	Velocity of Diffusion.	Rate of Effusion.
Hydrogen	3·83	3·613
Light carburetted hydrogen . .	1·344	1·322
Carbonic oxide	1·0149	1·0123
Nitrogen	1·0143	1·0164
Olefiant gas	1·0191	1·0128
Oxygen	0·9487	0·950
Protoxide of nitrogen	0·82	0.834
Carbonic acid	0·812	0·821

[TRANSPIRATION.]

EGG, WHITE OF. [ALBUMEN.]

EGG TRADE. Apart from the interest belonging to eggs in connection with natural history, there is much that is remarkable in their relation to commerce and manufactures. The egg trade is now one of great magnitude. What the number of English eggs produced and consumed, either as food or in manufactures, may be, it is impossible even to guess; for there are no returns which can apply to this subject; but of foreign eggs we find that there have been imported the following quantities in recent years :—

1844	67,000,000
1847	77,000,000
1850	106,000,000
1853 . .	123,000,000
1856 . .	117,000,000
1858 . .	135,000,000

These are principally obtained from France. The quantity imported in 1858 had a declared value of about 300,000*l*.

Eggs are largely employed in the leather manufacture, in the conversion of kid skins into leather for gloves and shoes. In one process of the manufacture, yolk of egg is mixed with alum, salt, and flour in a barrel, and the skins are agitated with this mixture for some time. Much of the softness of good kid leather is due to this use of egg-yolk. There is one leather-factory in Bermondsey where from 60,000 to 80,000 eggs are used for this purpose every year; they are imported from France in the spring, and are kept good throughout the year in lime-water.

Mr. Cooley makes the following observations on the preservation of eggs :—"Eggs may be preserved for any length of time by excluding them from the air; one of the cleanest and easiest methods of doing this is to pack them with the small ends downwards, in clean dry salt, in barrels or tubs, and to place them in a cool and dry situation. We have eaten eggs thus prepared that were more than twelvemonths old, and that had been for some months on shipboard, in a tropical climate, and which yet retained all the peculiar sweetness of new-laid eggs. With a like intention, eggs are placed in vessels containing milk of lime, or strong brine, or are rubbed over with butter, lard, or gum-water; all of which act by excluding the air. Eggs for keeping should never be laid on their sides; and when kept in the air, should be occasionally turned to prevent the yolk attaching itself to the side, instead of floating in the albumen. Some persons place the eggs in a netting, or on a sieve or colander, and immerse them for an instant in a caldron of boiling water, before packing them away. The practice of packing eggs in damp straw, or anything else that can convey a flavour, should be carefully avoided; the shells of eggs are porous, and readily admit the passage of gaseous substances, especially of fetid odours. It is from inattention to this point that a large portion of the eggs imported from the coast of France have a less delicate flavour than those of our poultry-yards. Damp dropped straw, as well as most other organic substances exposed to warmth and moisture, readily ferment or putrify; and during fermentation, a considerable increase of temperature takes place, as any one may readily perceive by examining the common hotbeds in our gardens, which are merely masses of organic matter in a state of decomposition. Eggs, as long as they retain the embryo of the future chick in a vital state, possess in themselves a certain degree of warmth, which tends materially to promote the decomposition of the substances they are packed in, particularly in the presence of moisture." In reference to the preservation of eggs, it may be stated that Mr. Jayne has patented a liquid for this purpose; consisting of two or three pounds of salt mixed with half a pound of cream of tartar, and dissolved in water to a brine strong enough just to float an egg. This liquid, it is stated, will preserve eggs fresh as long as two years; but Mr. Cooley is of opinion, that simple milk of lime will answer quite as well.

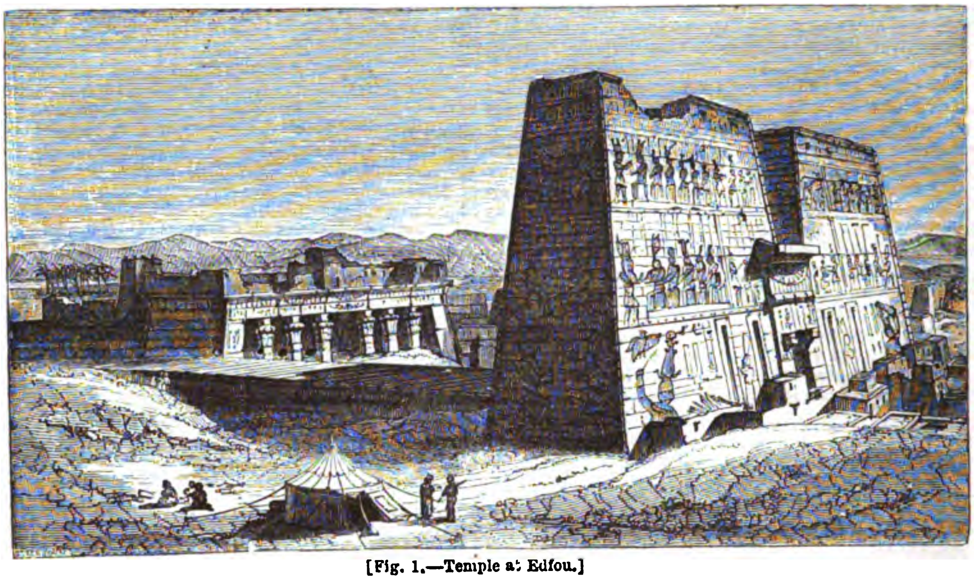
It affords a curious exemplification of the large scale on which the consumption of apparently trifling articles is now conducted, that in July, 1859, a suit in equity was tried between the inventors of two *egg-beating* machines. A patentee of a method of beating up the whites of eggs complained of another machine-maker for infringing his patent. The offender admitted the use, but denied the validity of the patent; and he brought forward proof that the inventors of two previously-patented churns, had anticipated all, or nearly all, that was really essential in the egg-beating machine.

EGYPTIAN ARCHITECTURE. The architecture of almost every civilised people can be traced to that of an earlier people or country, of which it is an adaptation or development. The architecture of Egypt is, however, an exception. It is the oldest architecture of which any examples remain, or of which we have any record; and it differs from all other architecture in its distinctive characteristics. In magnitude, solidity, and magnificence, it far surpasses that of every other country; but in unity of plan, grace of proportion, and æsthetic feeling, it will not bear comparison with the architecture of Greece. The ancient Egyptians appear in truth to have been not merely deficient in æsthetic culture, but their mental and national peculiarities were adverse to its reception. Further, they were controlled in all artistic work by immutable hierarchic rule, and free mental development was therefore impossible. The art of one age was, in a certain sense, that of all. If there was change, it was due to a change of dynasty, and therefore to a foreign influence.

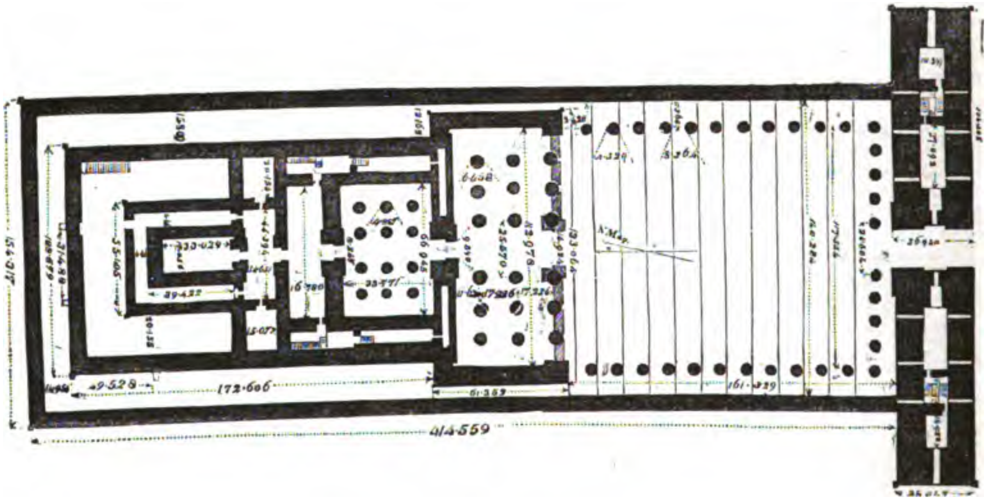
Were we to treat Egyptian architecture chronologically, we might divide it into the architecture of Lower, Middle, and Upper Egypt, and of Nubia; but we could not so treat it without entering into a fulness and minuteness of detail which would be quite out of place in a general sketch like the present. Within the limits assigned to us it will be most convenient to describe broadly the several great classes of structures, and the chief architectural members.

The most ancient edifices of Egypt are the pyramids, those of Gizeh being the earliest. But these we shall do little more than mention here, because, interesting as they are in themselves, they are structures of so very peculiar and distinct a nature as to have but little connection with the architecture of the country in general; being, when considered with reference to it, little more than uniform and simple though enormous masses. They are, in fact, greatly more important in an historical and archæological point of view than in one purely historical. Their shape is so familiar to every one that it requires no description, but may be defined as square in plan and triangular in section, its four sides being as many triangles united so as to terminate in a point; and as the height is much less than the width of the base, each side constitutes nearly an equilateral triangle. The extraordinary height and magnitude of these vast erections are combined with imperishable stability and solidity, the whole being nearly one entire mass of the hardest materials, for the inner galleries and chambers form but mere veins and cavities compared with the entire mass. For a description of them we refer to the article PYRAMIDS. For the same reason that we do not stay to describe the pyramids here, we may leave to a separate article those no less characteristic Egyptian monuments, the lofty four-sided monolithic shafts known to us as obelisks. [OBELISKS.]

The oldest really architectural Egyptian buildings are the great temples, or temple-palaces like that of Karnak; but as this enormous edifice was really an aggregation of buildings, the growth of ages, of which the nucleus appears to have been the sanctuary, built by Osertesen, the great king of the 12th dynasty, whilst the great court in front only dates from the 22nd dynasty, a clearer notion may be conveyed of the plan and character of an Egyptian temple by examining one of simpler form, though of later date. We select, therefore, as our example the temple at Edfou, or Apollinopolis Magna, erected under the Ptolemies, one of the largest and much the most complete of any in Egypt. Its dimensions are given on the ground plan. This it will at once be seen from the plan, was far more varied and complex than the plan adhered to by the Greeks, which, consisted merely of a cella, either surrounded entirely with columns, or with columns only in front, or at both ends. Here, on the contrary, the temple is placed within an enclosure, which forms also a court in front of it, surrounded on three sides by colonnades; and the entrance to this court was through a colossal doorway, or propylon, placed between two vast pyramidal towers, or as they are sometimes called pylons, covered with colossal figures in sculpture. These vast masses of structure, of which a much clearer notion will be formed from the cuts (*figs.* 1 and 2) than from a description, rose considerably higher than the temple itself. They are each 104 feet wide at the base, and diminish gradually to 84 feet at the summit, which is 114 feet high, and they were crowned by the usual cornice; they had likewise the torus moulding running up their angles, and are fine examples of their class. Other conspicuous objects frequently accompanying these propylæa, were lofty obelisks, as was the case at Luxor, where there still exist one in front of each tower. These towers may almost be said to be solid, for although they contained chambers and staircases, such spaces amounted to little more than voids left in the mass.



[Fig. 1.—Temple at Edfou.]

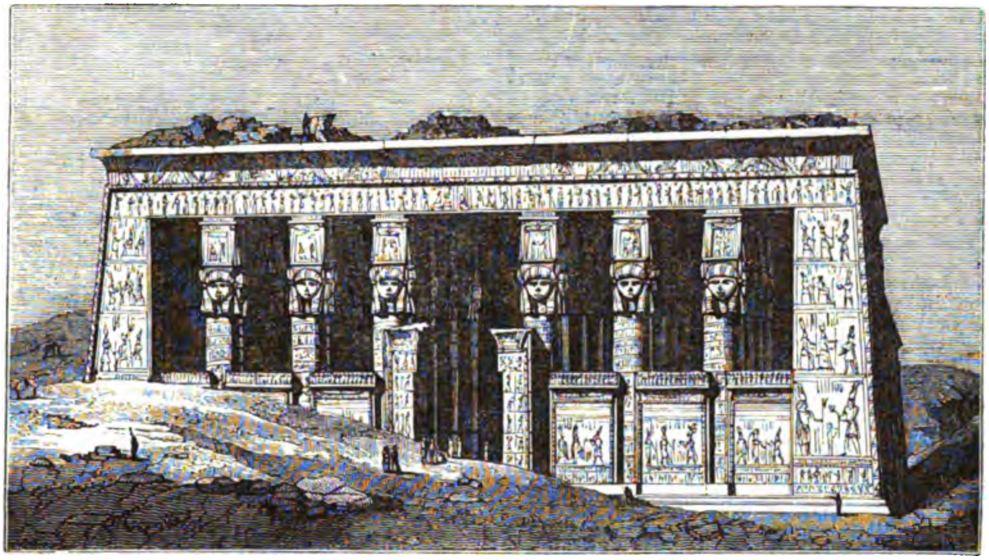


[Fig. 2.—Ground Plan of the Temple at Edfou.]

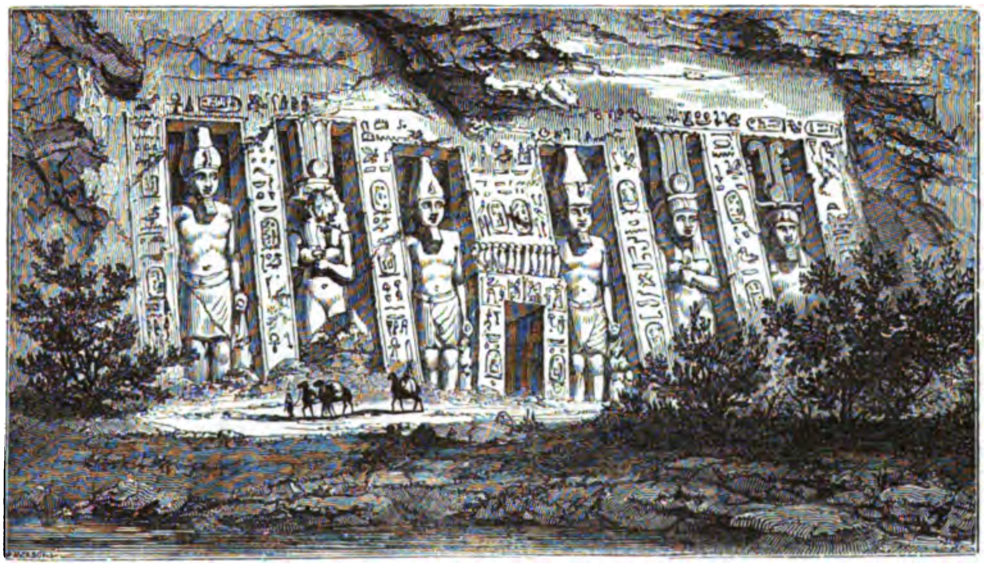
Between these towers is the door, which leads into a spacious court, having a colonnade carried along three of its sides. Within the court the colonnades were pycnostyle, or a diameter and a half apart, which seems to have been the usual mode of intercolumniation adopted by the Egyptians, the columns being seldom more than a diameter and a half from each other, except in the centre of a portico, where there was generally a doorway between the columns, the lower part of the other intercolumns being walled up, as described above, and as shown in the view of Denderah (*fig.* 3). The floor of this enclosure (now filled with rubbish and wretched buildings), rises by gradual steps (as shown by lines in the plan), to the portico or pronaos, which answers to the great hypostyle hall of Karnak, and other older temples. This pronaos is narrower, as well as smaller than the first hall, passages being cut off at its ends by exceedingly thick partition walls. It consists of eighteen massive pillars, six in a row, the intercolumniation, which forms the doorway, being as usual the greatest. Of the front pillars the intercolumniations are walled up to more than half the height. From this we pass into a still narrower and smaller hall which has three rows of four columns each, so disposed as to occupy the whole area, leaving merely narrow aisles in every direction between them—a mode peculiar to Egyptian architecture, occasioned by the necessity for employing such thickly-set columns to prop the massive beams and slabs of stone composing the ceiling; and hence such apartments have obtained the name of *hypostyle* halls. These pillars have quadrilateral Isis-headed capitals of the kind described below. To this hypostyle succeed two chambers, the farther one having smaller lateral rooms attached to it, which, it is conjectured, were appropriated to the use of the priests; and facing its entrance was that leading into the *sekos*, cella, or shrine containing the figure of the deity. Whilst all the preceding vestibules and chambers are placed transversely to the longitudinal direction of the building, the last and innermost apartment is parallel to that direction, and in continuation of the line of approach; the reason for which is obvious enough, it being almost indispensably requisite that the statue of the divinity should be at one end, and directly facing the entrance. In all probability likewise the object aimed at in disposing the rest as we perceive it to be, was twofold; first, for the sake of having a great number of apartments to be crossed before the sanctuary was reached and thus rendering it more difficult of access and more mysterious; and secondly, for the sake of contrast, the other divisions of the plan being intended to be merely passed through, but this, on the contrary, being the termination of the whole. If we keep this in view, and the peculiar nature of the worship to which these temples were dedicated, the arrangement must be allowed to be appropriate, notwithstanding that under different circumstances it might be objected to as constituting a very strong anti-climax since every portion of it successively diminishes, the last of the sacred chambers being, as the plan shows, hardly equal to the space forming the great doorway between the two towers. Yet what is thus an anti-climax, if we have regard to dimensions alone, became a perfect climax that must have made a powerful impression on those who were allowed to penetrate into the *adytum*—the most sacred part of the fane—the presence chamber, as it were, of the presiding divinity, where the sanctity of the whole precinct was concentrated in a focus, and to which the magnificence and colossal grandeur of all the rest served merely as preparation and prelude.

Such was the general disposition and distribution of an Egyptian temple. But, as was said above, in the older temples the hypostyle hall is a much larger and more important feature. That of the great temple of Karnak is 338 feet by 170 in extent, and has 134 columns disposed in nine parallel rows one way and sixteen the other. The hall consequently has the appearance of a grove of pillars; and their being so numerous and set so close together would have been no small inconvenience, had they not been of such prodigious bulk. But the smaller pillars of this hall are 9 and the larger 11 feet in diameter, and the intercolumniations are consequently equal to 13½ and 16½ feet. The central pillars are 70 feet high to the under side of the architrave. The area of this vast hall is 57,629 square feet; or with its two pylons, upwards of 80,000 feet—an area, as has been pointed out, greater than that of Cologne Cathedral, the largest of the Gothic cathedrals of Northern Europe, whilst four such churches as that of St. Martin's-in-the-Fields, London, would stand side by side within the hall without occupying its entire area. The effect of this vast grove of columns is spoken of by all who have seen it, as being surpassingly grand. The length of the entire building is upwards of 1200 feet; its breadth varies from 321 to 360 feet. It has twelve principal approaches, each of which has lofty doorways placed between enormous pylons, and before them have stood colossal statues, whilst avenues of sphinxes lead from them in various directions, one being continued the whole way across the plain to the temple at Luxor.

The engraving of the front of the great temple of Denderah (*fig.* 3), the most perfect of the existing monuments of Egypt, will serve to show the character of Egyptian architecture at a somewhat later date than that of the temple at Edfou. The temple, which is of vast extent, is enclosed within a square wall, the side of which is 1000 feet, and which is in parts 35 feet high and 15 feet thick. In general form this temple resembles that at Edfou, but it has no forecourt or propylon. This façade from its perfectness exhibits very distinctly the sloping profile of the walls, the peculiar entablature, and the hieroglyphic carvings, all of which are so characteristic of Egyptian architecture, as well as a remarkable form of capital. Later temples show more irregularity of plan.


[Fig. 3.—Front of the Temple at Denderah.]

In Upper Egypt and Nubia occur temples hewn out of the solid rock; but, like all excavations, they are copies of structural temples. The most remarkable is the great rock-temple of Ipsambul, or Abou-sambul, constructed by Rameses III. It has two faces formed out of the sandstone rock, each cut to resemble the front of a temple, while the temple itself penetrates 180 feet into the mountain. The front of the temple is nearly 100 feet high and 117 feet wide, and is adorned with four enormous colossi each 70 feet high, which produce a wonderfully impressive effect. The interior is in general plan like that of the structural temples; the first apartment is a pronaos 57 feet long and 52 feet wide, supported by two rows of large square caryatide pillars, in a line with the door of the sakos; beyond this is a smaller hall, supported by four columns; the sakos, or sanctuary, is 23 feet long by 12 feet wide, with a pedestal in the centre, and at the end four colossal seated figures. With the side or priests' rooms, there are in all fourteen different chambers. A smaller rock-cut temple at Abou-sambul is greatly inferior in design, but has a richly carved front 90 feet long, in which are six colossal figures hewn out of


[Fig. 4.—Smaller Temple at Abou-Sambul.]

the rock. (*Fig.* 4.) The extreme end of this temple reaches 76 feet into the rock.

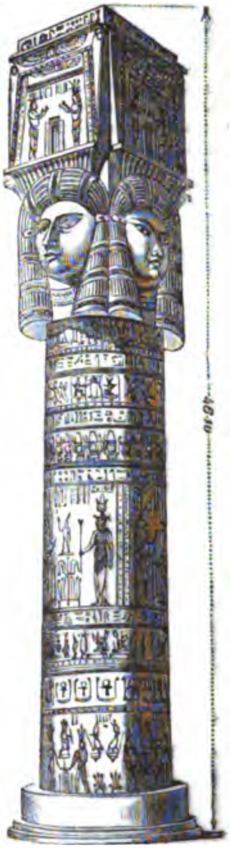
Having thus described the general plan and arrangements of the temples as the chief and most characteristic class of Egyptian buildings, we proceed to notice some of the principal elementary parts of which they are composed.

The diversity observable in Egyptian columns is so great that it is impossible to specify here all their varieties, which can be understood only by studying the engravings in the large works devoted to Egyptian antiquities. Nor can they be reduced to any system, there being no peculiar form of capital or other distinct characteristic attaching to any particular type of column; nor anything in regard to proportion whereby they can be classified. There can be little doubt that the oldest and simplest form of Egyptian column was that of a plain square pier. From these, octangular, polygonal, and eventually cylindrical columns, were produced by the simple process of cutting off the angles. As a general rule, Egyptian columns, of whatever kind, were vertical in profile, thus contrasting in a marked manner with the sloping profile of the building. It must not be understood, however, that the shafts are either invariably or perfectly cylindrical, but that such was their general form. There is sometimes a slight difference between the upper and lower diameter; or else the shaft is cinctured at intervals by bands consisting of three or more rings encircling it, and thereby increasing the diameter in those parts. In addition to this species of ornament, the shaft was variously decorated in other respects, the spaces between the bands being sometimes sculptured with hieroglyphics; at others, reeded, that is, its surface was divided into a series of upright mouldings, or staves, so as to have the appearance of a bundle of smaller pillars bound together, and which, with the encircling of the shaft with ring mouldings, has suggested the idea of their being an imitation of reeds, or thin palm stems, banded together. The kind of striating, or striping, just described, is the reverse of that practised in the Doric and other Grecian orders, since in the latter it was produced by concave channels, or flutings, but in this by convex surfaces. In the rock-cut tombs of Nubia, however, true-fluted proto-Doric columns occur, the only character of the Greek Doric absent being the echinus moulding under the abacus: a characteristic example is that of the tomb at Beni-Hassan. Under COLUMN (col. 44) is a cut of an Egyptian column, now in the British Museum, in which are shown the cartouches of hieroglyphics spoken of above.

Egyptian columns have rarely any distinct base, seldom more than a circular plinth; but they have frequently an ornamental footing, which differs however from a base in being contracted instead of expanded below. It may be described as shaped like the calyx of a flower, the resemblance to which is increased by its being sculptured into some forms of foliage, so that the shaft appears to be set in and rise out of a plant. Of this description are the bases of the columns of the temple at Latopolis or Esné. By some this has been insisted upon as a defect and as indicative of weakness: consequently, contrary to that law of architecture which prescribes that there should be apparent as well as real strength, more especially where the expression of solidity is naturally looked for. Still it may not unreasonably be urged that, as in all such cases, the judgment comes to the aid of and corrects the eye: what is known to be strong cannot fairly be said to appear weak; and the solidity of columns which have stood the test of some thousands of years cannot possibly be called in question. It may ndeed be argued that the excess of strength which they gave their structures, and the prodigious solidity and durability of the materials employed, allowed the architects of Egypt to contract the diameter of their columns below, without rendering them at all weak.

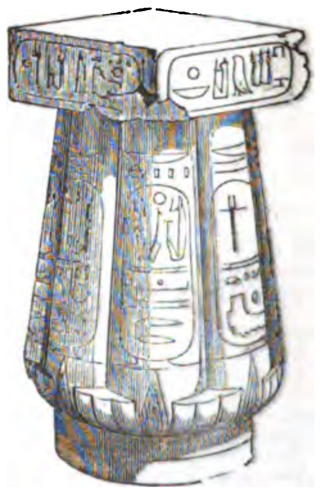
The most usual form adopted for capitals was that of the cup of the papyrus or the calyx of the lotus, but occasionally of some other flowers, with a rim bending downwards, which was sometimes quite circular, at others jagged, the circumference being divided into a number of convex curves, forming so many distinct petals. The six specimens given in the article COLUMN (col. 46) exhibit two of the latter and three of the first-mentioned variety of the bell-shaped capital.

From these it will be seen what variety prevailed in the decorative details, some being cut into distinct leaves, either convex or concave, others embellished with sculpture representing branches and flowers. It will also be perceived that, in their general mass, the capitals of this class, far from having anything in common with that of the Grecian Doric, bear a general similarity to that of the Corinthian order, though both the foliage and its arrangement are of a different character. Yet there is not now much doubt that the Greek Corinthian order may, like the Doric, be traced to an Egyptian source. But there exists an exceedingly wide distinction between the Egyptian and every variety of either Grecian or Roman capitals; namely, in the abacus being a mere square plinth, considerably smaller than the capital. The Egyptian abacus is anything but ornamental in itself, and would be a defect, were it not that in the buildings it can hardly be seen, owing to its smallness and the projection of the rim of the capital; consequently, unless it happened to be very deep, it serves chiefly to detach the capital from the architrave, and prevent that heaviness of appearance which would otherwise be occasioned. The first figure among the specimens given under COLUMN shows an example of what may be termed the double capital, peculiar to Egyptian architecture; for above the usual shaped capital is a square member, sculptured on each of its sides with an Isis' head; and on this again is placed a second square member, so that instead of a double this may be termed a triple capital. The columns of the temple at Denderah (*fig.* 5) offer another instance of the double capital in some respects similar to, in others greatly differing from the preceding. Here the lower capital consists of four Isis' faces, disposed so as to form a square, larger than the shaft, the folds of the head-dress hanging down and projecting beyond it: above each face is a kind of fluted abacus, and above is a square member. The shaft also varies considerably from those shown in the preceding examples; for instead of being striated vertically and banded horizontally, this is covered with hieroglyphics disposed in series of rings. Another remarkable circumstance is the great height of the whole capital, it being not less than two-fifths of the shaft.



[Fig. 5.—Column from Denderah.]

There is another species of capital of very frequent occurrence, which is distinct from either of the above two classes; and although its form may at first sight be considered uncouth, it is well calculated for effect. After sweeping out from the shaft, instead of continuing to expand as it proceeds upwards, it slopes back so as to diminish until it



[Fig. 6.—Egyptian Capital, in the British Museum.]

is contracted again to the diameter of the shaft itself. The decoration consists in its being subdivided into eight lesser shafts, inscribed with hieroglyphics, as are likewise the faces of the abacus, which member here becomes very pronounced, and occasions a picturesque play of light and shade. Capitals of this kind, as well as other varieties, occur at Luxor. In their proportions, Egyptian columns vary no less than in other particulars, their height amounting in some instances to no more than three diameters, in others extending to eight or upwards. Yet such difference is not attended by any regularly corresponding one, either as regards the column itself or the parts connected with it. Further, it is by no means unusual to meet with square pillars or *tetrapleurons*, with either a statue or a caryatide figure standing before but distinct from it. One of these from Medinet Abou is figured under ATLANTES (vol. i. 689). There are also terminal caryatide columns at Karnak.

The Egyptian entablature is so far from displaying anything like the same variety as the columns, that it is nearly uniformly the same in buildings which differ very much from each other in regard to their columns. Unlike that of the Greeks, it consists of only two divisions, the epistylium or architrave, and the cornice; the height of both being generally one-third of that of the columns. More frequently than not the epistylium was enriched with sculpture in hieroglyphics, which circumstance alone constitutes a great difference between the practice of the Egyptians and that of the Greeks. Another singularity is, that the epistylium was included within the convex moulding or *torus* carried up at the angles of the building, and then returned horizontally along the front, owing to which the architrave itself (epistylium) appears to be returned downwards, like that of a door or window. This will be at once understood by referring to the view of Denderah (*fig.* 3), by which it will also be seen that the cornice consists of little more than a deep cove enriched with sculpture,—a form peculiarly adapted for effect in a climate like that of Egypt, as it not only casts a bold shadow but receives a strong reflected light.

With the cornice the building terminated, for the roof being a flat terrace, there was no indication of roof; consequently Egyptian architecture is entirely destitute of what are such expressive and highly ornamental features in that of Greece, namely, the pediment, antifixæ, and ridge tiles. By way of indemnity for its deficiency in this respect, and the sameness arising from it, greater latitude was allowed to it in others. Not only was there far greater diversity in the forms and ornaments of columns, which do not appear to have been subject to any regulations beyond those prescribed either by symbolic allusions or by national taste; but columns of very different character appear in the same edifice, and even capitals of different design in the same range of columns. Another thing peculiar to Egyptian buildings is the frequent use in the external porticoes of temples of intercolumnar walls, or screens, that is, walls built between the columns and carried up half their height; thereby giving to the open part of the intercolumns above them somewhat the appearance of windows. For an example, we again refer to the view of Denderah, in which instance these walls are brought forward so as to encase the shafts of the columns between them, and fling a shadow upon them. Like every other part of the front in the same edifice, these walls are decorated with sculpture and hieroglyphics; for the Egyptians were exceeding lavish of that species of embellishment, not confining it to particular situations, as did the Greeks, namely, to the pediment, frieze, and inner frieze behind the columns, along the walls of the cella, but extending it over the entire surface, in compartments forming tier above tier. These architectural sculptures were generally in very low relief, and some of them also occasionally in intaglio, or hollowed into the surface instead of projecting from it. There are even instances of a combination of both modes, the figures being outlined by a groove or incision, so as to give them greater apparent relief; a mode that has been denominated by some intaglio-rilevato. In addition to this species of enrichment must be added that of colours and gilding: the whole of the sculpture which covered the walls, the capitals of the columns, and much, if not the whole, of the columns themselves, and the beams and ceilings, were brilliantly coloured. The colours employed in all parts of Egypt were, according to Sir Gardner Wilkinson ('Anc. Egyptians,' iii. 301), red, green, and blue; and when black was introduced yellow was added to harmonise it. Fairly to estimate the effect of this, as it might otherwise seem, excessive polychromatic decoration, the extreme brilliancy of the Egyptian climate must be constantly borne in mind.

In Egyptian architecture, even more than in Grecian, doorways are conspicuous and important features, where they occur as distinct parts of the design in the form of towers; sometimes standing quite insulated after the manner of arches or gateways; yet more usually placed between and connecting two pyramidal pylons that rise to a great elevation above the propylon itself; consequently such entrance is both lower and narrower than the parts attached to it. In its general form the propylon or gateway resembled the temple itself, yet with this difference, that the proportions of the propylon are lofty and narrow; those of the temple wide and low, and its opening filled with columns supporting the lintel or epistylium. Their similarity in all other respects is obvious enough, owing to the epistylium of the portico being returned and carried downwards just as the lintel of the door is in order to form its jambs. The outer angles are similarly inclined in both cases, and ornamented with the same torus moulding on their edge. It should be understood, however, that the jambs of the doorway were for the most part, not vertical next the opening, but sloped like the external angles, so that the aperture was narrower at the top than at bottom, which form seems to have been copied by the Greeks in that of their doors and windows. The lintel and cornice above it were also proportionably much deeper than the epistylium and corresponding member, over columns, in order to produce sufficient mass; otherwise the effect would have been both unarchitectural and disagreeable, too much like that of the mere framing of a door, standing, although not quite insulated, yet distinct from the rest of the composition. Some idea may be given of the imposing magnitude of such doorways or propyla, by stating that the one at Edfou measures 74 feet to its summit, and 51 to that of the aperture, which gives a depth of 23 feet, or nearly one-third of the whole height, for the lintel and cornice.

The magnificence of these propylea was greatly enhanced by colossal statues or obelisks—in some instances both—placed on either side of the entrance. Besides which there were sometimes two or even more propylea and courts preceding the temple, which were in their turn preceded by avenues of gigantic sphinxes or crio-sphinxes (that is, sphinxes with rams' heads). There are, likewise, instances of avenues of columns crossing the courts in a line from the entrance. The remains at Luxor furnish an example of the kind, where, after the first court (which has a double peristyle), there is a second with a double range of columns extending down it, that are 11½ feet in diameter and 56 high, and beyond this was a third court, flanked by colonnades, consisting of double rows of pillars.

Of the domestic architecture of the Egyptians there are but few vestiges left. The so-called temple-palaces have but little of the character of even a royal residence. At Medinet Abou, in Western Thebes, enclosed within an extensive brick-wall are a temple, or building that has been called a palace, but appears to be also a temple, and a much smaller structure which is considered to have been a royal pavilion erected by Rameses II. All that remains of this last is a singularly picturesque structure two stories high, though it was originally, no doubt, a three-story building, with three rooms with long-connecting corridors on each floor. The chief front is sculptured with colossal figures, has wide window openings, and is crowned with the usual cornice.

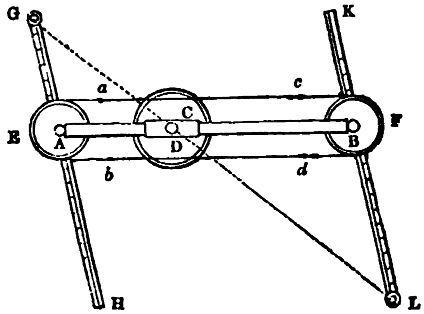
Of the mansions of the higher and affluent classes, pretty nearly all that is known is derived from Egyptian paintings. These have been most thoroughly examined by Sir J. G. Wilkinson, and the little it it seems necessary to add on this subject we borrow from him. The private houses of the Egyptians, and indeed all buildings, except temples and temple-palaces, appear to have been built of crude brick. The town-houses of wealthy citizens frequently covered a considerable space, were seldom more than three stories high, and presented to the street either the sides of the house itself, or the walls of the court attached to it. Sir Gardner Wilkinson ('Ancient Egyptians,' vol. ii. 101-4), thus describes these buildings: "Their plans were regular, the rooms being usually arranged round an open area, or on either side of a long passage to which an entrance-court led from the street. The court was an empty space, considerably larger than the Roman impluvium, probably paved with stone, or containing a few trees, a small tank, or a fountain in its centre; and sometimes, though rarely, a flight of steps led to the main entrance from without. A court was frequently common to several houses: and again, some of the large mansions stood detached, and had the advantage of several doors of entrance, on two or three different sides. They had a portico, or porch, before the front door (janua), supported on two columns, below whose capitals were attached ribands or banners: the name of the person who lived there being occasionally painted within, on the lintel, or imposts of the door; and sometimes the portico consisted of a double row of columns, between which stood colossal statues of the king. A line of trees ran parallel with the front of the house; and, to prevent injuries from cattle or from any accident, the stems were surrounded by a low wall, pierced with square holes to admit the air. The height of the portico was about twelve or fifteen feet, just exceeding that of the cornice of the door, which was only raised by its threshold above the level of the ground. On either side of the main entrance was a smaller door, which stood at an equal distance between it and the side wall, and was probably intended for the servants, and those who came on business. On entering by the porch, you passed into an open court (*aula*, or hall), containing a *mandara*, or receiving-room, for visitors. This building, supported by columns, decorated with banners, was closed only at the lower part by intercolumnar panels, over which a stream of cool air was admitted, and protection from the rays of the sun was secured by an awning that covered it. On the opposite side of the court was another door, the approach to the *mandara* from the interior; and the master of the house, on the announcement of a stranger, came in that way to receive him. Three doors led from this court to another of larger dimensions, which was ornamented with avenues of trees, and communicated on the right and left with the interior of the house; and this, like most of the large courts, had a back entrance (*posticum*), through a central and lateral gateway. The arrangements of the interior was much the same on either side of the court: six, or more chambers, whose doors faced those of the opposite set, opening on a corridor supported by columns on the right and left of an area, which was shaded by a double row of trees. At the upper end of one of these areas was a sitting-room which faced the door leading to the great court; and over this and the other chambers were the apartments of the upper story. Here were also two small gateways looking upon the street." The floors were made of stone, or cement; the roofs were supported by rafters of the date-tree arranged close together, and sometimes vaulted, being built like the rest of the house of crude brick. On the top of the house was a terrace, covered by a roof supported by columns. The porticoes, walls, ceilings, &c., were all elaborately painted in patterns. The country-houses of the nobles were very commodious mansions, with spacious gardens, fish-ponds, farmhouses, granaries, &c., attached. "Some large mansions appear to have been ornamented with propyla and obelisks, like the temples themselves; it is even possible that part of the building may have been consecrated to religious purposes, as the chapels of other countries, since we find a priest engaged in presenting offerings at the door of the inner chambers; and, indeed, but from the presence of the women, the form of the garden, and the style of the porch, we should feel disposed to consider it a temple rather than a place of abode. The entrances of large villas were generally through folding-gates, standing between lofty towers, as in the propylæa of temples, with a small door at each side; and others had merely folding-gates with imposts surmounted by a cornice. A wall of circuit extended round the premises; but the courts of the house, the garden, the offices, and all the other parts of the villa, had each their separate enclosure. The walls were usually built of crude brick; and in damp places, or when within reach of the inundation, the lower part was strengthened by a basement of stone. They were sometimes ornamented with panels and grooved lines, generally stuccoed; and the summit was crowned either with Egyptian battlements, the usual cornice, a row of spikes in imitation of spear-heads, or with some fancy ornament." (Wilkinson, ii. 128.)

One other class of structures—the tombs—requires a word of notice since, besides possessing some points of architectural interest, it is from them that we derive by far the greater part of our knowledge of the arts and civilisation of ancient Egypt. Of these, the oldest and most important, if we omit the pyramids, are the tombs of the Theban kings, in the valley of Biban-el-Meluk, which are excavations in the solid rock, often of great extent. Many of them have a rich architectural entrance façade, and all have their interior walls covered with paintings and hieroglyphs of exceeding value from the information they afford respecting the manners, customs, and history of the people. Of these tombs, the most famous is that of Manepthah, who built the great hypostyle hall at Karnak, which extends in a sloping direction for about 350 feet into the mountain, and which terminates in a spacious chamber, in which stood the costly sarcophagus. Many of the later tombs are commonly of crude or unburnt brick. These tombs have a peculiar interest in connection with the history of architecture, as presenting unimpeachable evidence of the remote antiquity of the invention of the arch. A tomb at Thebes, which belongs, according to Wilkinson, to the reign of Amunoph I. (B.C. 1540) has a vaulted brick roof; and in a tomb at Sakkara of the time of Psamaticus II. (B.C. 600), whose name is engraven on it, occurs an arch of stone. But though these and other examples prove that the Egyptians were acquainted with the theory of the arch, they appear only to have employed it in pyramids, tombs, and underground structures.

EIDER DOWN. This beautiful substance is obtained from one species of the duck, called the eider duck, found extensively in the icy seas of the north. There are two kinds of eider down, the live and the dead. The live down consists of the exquisitely light feathers which the duck strips off from herself to keep her progeny warm in the eggs. Its lightness and elasticity are such that two or three pounds of it, squeezed into a ball which may be held in the hand, will swell out to such an extent as to fill a case large enough for the foot-covering of a bed. The quantity of down afforded by one duck during the whole period of laying is about a pound. The down-gatherers are obliged to be cautious not to carry their somewhat cruel robbery too far, or the ducks will not again return to the same spot. Any district in which the eider duck is willing to settle is regarded as a valuable property in Norway and Iceland, and the landowners do their best to encourage their settlement. The *dead* down is that which is taken from the dead duck; it is inferior to the live down. Eider down is used chiefly in connection with beds and bedding.

EIDOGRAPH, from the Greek words εἶδος, a form, and γράφω, to draw, is an instrument invented in the year 1821, by the late Professor Wallace of Edinburgh, and described in the 'Transactions of the Royal Society of Edinburgh,' vol. xiii. It is a species of pantograph, and, like the latter, it is used for the purpose of copying plans or other drawings on the same or on different scales.

A rod or beam A B of brass, 30 inches long and five-eighths of an inch square, and made hollow for the sake of being light, slides freely through a hollow rectangular socket C, whose length is 4½ inches; from the lower surface of this socket projects a steel pin of a conical form, and serving as an axis; the pin entering into a tube of a corresponding form which stands vertically on a cylindrical mass D of metal. The mass serves as a base for the whole instrument; and while the beam A B may slide horizontally in the socket C, it is capable of turning with the socket upon the vertical axis in the tube. Each end of the beam A B carries a short tube in a vertical position, and through this passes the conical axle of a wheel or pulley E or F, which is placed below the beam; these wheels are precisely equal in diameter, and are capable of turning freely on their centres in a horizontal plane.



The vertical edge of each of these wheels is grooved so as to receive a piece of very thin watch-spring *a* E *b*, C F *d*; and the ends *a* and *c*, *b* and *d* are connected by a steel wire; the pieces of watch-spring are made fast near E and F to the circumferences of the wheels, in order to prevent them from slipping on those circumferences; a small movement for the sake of adjustment only being allowed. Swivel screws at *c* and *d* serve to tighten or relax the band as may be necessary.

Under each of the wheels E, F, is fixed a rectangular socket similar to C, and in this slides, horizontally, a rectangular arm G H, K L, each of which is 27½ inches long: these arms, which turn with the wheels E and F, are adjusted by means of the screws at *c* and *d*, so as to be always parallel to one another. At L is fixed a tracing point, like that of a pantograph; and at G a pencil in a socket or tube; the tracer and pencil are to be always in a straight line, passing through the common axis of the mass D, and of the socket C. The pencil is made to press gently on the paper by weights, but it is capable of being raised from thence at pleasure by means of a lever, one end of which is connected with the socket which carries it, and to the other is attached a string which is to be pulled by the operator when necessary: this movement of the pencil carrier is facilitated by means of small friction rollers.

The beam A B is divided on its upper face in 100 or 1000 equal parts, and divisions equal to these are set on the upper face of each arm G H, K L. By these divisions the distances of A and B from the axis of D may have any given ratio to one another, and A G, B L may respectively be made equal to the last-mentioned distances. Thus, the isosceles triangles G A D, D B L will always be similar to one another; and the figure described by the movement of the pencil at G will be similar to the original figure over which the tracer at L may be made to pass. Consequently, a given plan or drawing may be enlarged or reduced in any required proportion.

Professor Wallace contrived an instrument which he called a 'Chorograph,' for describing on paper any triangle, having one side and all its angles given; also for constructing two similar triangles on two given straight lines, having the angles given. See 'Geometrical Theorems,' &c. By William Wallace, LL.D. Edinburgh, 1839.

EIGHTH (in music), the octave or eighth note of the diatonic scale. It is a perfect concord [CONCORD], and in harmony is accompanied by the 5th and 3rd; but being almost identical with the base note, it may form a part of any chord, or be omitted at discretion.

EISTEDDFOD, from *eistedd* to sit; a meeting or assembly. This term was more especially used as the name for the session of the bards and minstrels which was held in Wales for many centuries. [BARD.] Near the close of the last century some Welsh gentlemen determined to endeavour to establish bardic meetings. The experiment proved extremely popular, and ever since periodical meetings, to which the name of Eisteddfod has been given, have been held successively in the principal towns in Wales. The principal object of these modern eisteddfodau has been to encourage the study of the Welsh tongue, and to keep alive a national spirit; and with that view prizes are awarded to the best Welsh poet, the best player on the Welsh harp of national melodies, &c.

EJECTMENT is the name of an action at law, by which a party entitled to the immediate possession of lands or other corporeal hereditaments may recover that possession from the party wrongfully withholding it.

Since the disuse, and subsequent abolition, of real actions, it has become the only legal mode of trying the title to lands and tenements. The procedure in it was re-modelled, and is now regulated entirely by the Common Law Procedure Act of 1852.

The old remedy by ejectment, better known as *John Doe* v. *Richard Roe*, was founded almost entirely upon a succession of legal fictions, and it is therefore necessary to give a short account of its history and the proceedings under it.

Originally this action was brought by any person having a lease of lands, to repair an injury done him by dispossession; but gradually it became the means of indirectly bringing in question the title to the lands, which was thus collaterally tried with the supposed trespass. For this purpose it was necessary that the claimant should enter upon the lands in order to empower him to constitute a lessee for years who would be capable of receiving the injury of dispossession. A lease for years was therefore stated to have been made by the party claiming title to the plaintiff, who was a fictitious person, John Doe. It was also stated that the lessee, in consequence of the demise to him, entered into the premises, and that the defendant, who was also a fictitious person, Richard Roe, and called the *casual ejector*, entered thereupon and ousted the plaintiff, for which ouster the plaintiff brought his action.

A notice professing to be written by the casual ejector to the tenant in possession of the premises, advised him to appear in court at a certain time and defend his title; otherwise he, the casual ejector, would suffer judgment to be had against him, by which means the actual tenant would inevitably be turned out of possession.

The declaration, in the action, formally stated the *lease*, *entry*, and *ouster*, and it and the notice were then served upon the tenant in possession of the premises, who had thus an opportunity of defending his title. If he omitted to do so within a limited time, he was supposed to have no right; and upon judgment being obtained against the casual ejector, the real occupier was turned out of possession by the sheriff.

If the tenant applied to be made a defendant, he was allowed to appear upon condition that he entered into a rule of court to confess at the trial of the cause four of five requisites for the maintenance of the plaintiff's action—the lease of the lessor, the entry of the plaintiff, the ouster by the tenant himself, and the possession by the tenant. These requisites were wholly fictitious; and if the plaintiff should put the defendant to the proof of them, he would of course be nonsuited at the trial; but the stipulated confession of lease, entry, and ouster being made, the case then rested upon the merits of the title only, and the cause went to trial under the name of the fictitious lessee on the demise of the lessor, who was the person really claiming title against the defendant.

The lessor was bound to make out on the trial his title to the premises; and if he did so in a satisfactory manner, judgment was given for the nominal plaintiff, and a writ of possession went to the sheriff to deliver up the possession to him, under which process it was in fact delivered to the real claimant. If it appeared that the person claiming title had no right of entry, that is, no right to the immediate possession, he could not maintain his action.

The Common Law Procedure Act, 1852, has abolished the fictions above alluded to, by substituting for the declaration *Doe* v. *Roe* and the notice by *Roe* to the tenant in possession, a single writ, directed to the tenant in possession, in which the plaintiff asserts his right to the property described in it. If the tenant, or his landlord who is entitled to notice from the tenant, disputes the claimant's right, one or other must appear and defend the action, the appearance being construed to be a denial of the title of the claimant, on which the parties may proceed to trial. If the tenant or his landlord does not appear, the claimant obtains an ordinary judgment by default, on which the sheriff gives him possession.

A mortgagee may maintain an action of ejectment against the mortgagor to gain possession of the mortgaged premises without giving any notice, unless the mortgagor is protected by the covenant for quiet enjoyment until default. He may also eject the lessee, to whom the mortgagor has made a lease subsequent to the mortgage, without giving him notice to quite. Where the right of the tenant to retain the possession has ceased by effluxion of time, by a legal notice to quit, or by the commission of an act of forfeiture, a landlord may bring an ejectment against his tenant; and various other persons who have a right of entry in law upon the premises may take advantage of the same remedy.

The time within which an action of ejectment may now be brought is regulated by the 3 & 4 Will. IV. c. 27, which enacts that no person shall bring an action to recover any land or rent but within twenty years next after his right to bring such action, or that of the person through whom he claims, shall have first accrued. The third section fixes the time at which the right shall be deemed to have first accrued. (Blackstone's 'Commentaries,' Mr. Kerr's edit., vol. iii. p. 206.)

ELAENE. [Nonylene.]

ELÆOPTENS. [Essential Oils.]

ELAÏDIC ACID. [Oleic Acid.]

ELAÏDINE, a fatty substance, of uncertain composition, produced by the action of nitrous acid upon certain oils, as olive and almond oil, &c. This substance is white, inodorous, insoluble in water, and fusible at 95° Fahr. It is soluble in ether, and in 200 times its weight of boiling alcohol; when treated with potash it saponifies, giving rise to glycerin, and a peculiar acid which has been called elaïdic acid. This acid is solid, fusible at 112° Fahr., and is partially distilled by exposure to a strong heat. [Oleic Acid.]

ELAIÖDIC ACID. [Ricinolic Acid.]

ELALDEHYD. When aldehyd is kept for some time in sealed tubes, it is converted into two polymeric bodies, *metaldehyd*, a hard crystalline inodorous solid, and *elaldehyd*, which is a liquid. [Othyl, Hydride of.]

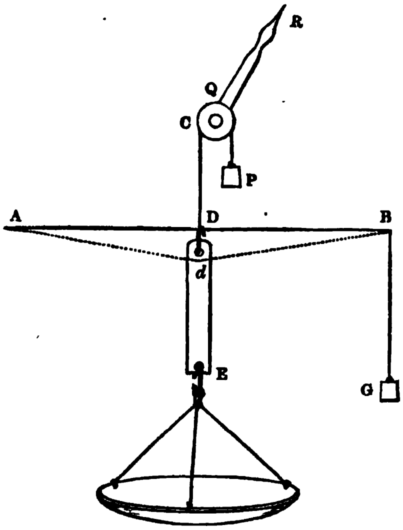
ELASTICITY. When the form of a body is affected by the pressure of another extraneous to it, the re-acting force by which it sustains or tends to remove that pressure is its elasticity. This energy of restitution is thus defined by D'Alembert:—"La force elastique est une propriété ou puissance des corps, au moyen de laquelle ils se rétablissent dans la figure et l'étendue, qu'une cause extérieure leur avait fait perdre." The term has been very loosely used in popular works, which, instead of furnishing an exact and general idea of this force, are, in general, limited to the phenomena exhibited by elastic solid bodies; and to this imperfect notion of elastic force we are to attribute the discrepancies of treatises, some of which used to represent water as perfectly inelastic, some (as the more modern treatises) as perfectly elastic. The cause of elasticity then belongs to the theory of molecularity, its effects in aggregate masses to mechanics.

The equilibrium of the *molecules* of solid bodies is almost completely dependent on their own mutual actions and quantity of heat. These forces determine certain mean places for the constituent particles, to which points of stable equilibrium they tend to return when removed a little from them by an external force. This removal may be such as to effect in the mass either compression or extension, inflexion, or torsion, and therefore their elastic force is capable of being exhibited in all these ways. It is demonstrated in fluids only by their compressibility, while in gases it acts as a predominant living force which would refuse any position of equilibrium to the constituent particles without external pressure, and is proportional to such pressure uniformly exercised.

When heat is applied to a solid elastic body, that is, when its temperature is raised, the particles seek a different position of equilibrium more remote from each other than before. But while this heat is much below that necessary for friction, or for destroying the fibrous formation of organized matter, the stability of the removable particles is but little affected, and experiment shows that there is scarcely any change of elasticity. In fluids the compressibility obtains a greater range, while in gases, where no countervailing force of attraction is sensible, the increase of temperature is accompanied by a proportional increase of elastic force.

Amongst bodies whose elasticity is very apparent, we may enumerate glass, ivory, caoutchouc, sponges, and fibrous substances, as beams, muscles, and artificial webs, some gums, steel, and all the gases and vapours. In gases and vapours its effects may be produced to any extent, but they are limited in solids by their softness and facility of fusion, as in wax, lead, &c.; by their absorption of moisture, as in clay, feathers, catgut, straw; or by their friability, as in glass, dry resins, and copper or iron which have been exposed to a stream of ammoniacal gas.

Suppose an elastic string, or lamina, to be fixed at one end, and at the other stretched by a force T, which will also represent its tension; if this force be increased by a small quantity t, an additional length l would be given to the string, or lamina; the whole tension now is $T + t$, and if we again add a force t, since the physical condition of the body is sensibly the same as before, the same length l will again be added, and generally the additional extension should be proportional to the additional tension: this law is, however, only approximative, for it is manifest that a force tending to produce either extension or contraction may be applied which would cause the body to break, and near these limits the law would vary considerably from simple proportionality. Let a horizontal elastic lamina AB be fixed by a screw at A, and having been stretched by a known weight G at B, let it be screwed also at that point, when its tension will evidently be equal to the weight appended; let the beam DE of a balance F be sustained at D, the middle of AB through a drilled orifice d, and be attached to a string passing over the fixed pulley C, which string also sustains a weight P, which is an exact counterpoise to the weight of the scale and beam so that they may produce no deflection of themselves in AB; then if a small weight be put into the scale, the lamina ADB will be bent into the form AdB, with a deflection Dd from its original



position, which may be estimated with greater accuracy by a hand QB attached to the pulley. An extension AdB — ADB will thus be produced, as well as an increase of tension, which may then be compared by the common laws of statics; and the experiments show that as long as the added weights are small, "this *extension* is proportional to the increase of *tension*." This law is that expressed by Hooke: "*Ut tensio sic vis.*"

When a uniform elastic string is suspended vertically it will be stretched by its own weight. The tension varies from point to point, and is everywhere proportional to the portion of the string of which it supports the weight. If y be a portion of the stretched string corresponding to a portion x of the same unstretched, and $y+\triangle y$, $x+\triangle x$, another corresponding pair of portions greater than the former, and a the whole length of the string in its natural state, the extension $\triangle y - \triangle x$ of the element $\triangle x$ is proportional to the weight of the remaining portion $a-(x+\triangle x)$ of the string; hence if g denote the weight of a unit of the string, and e the index of elasticity peculiar to the substance, we have ultimately [DIFFERENTIAL CALCULUS] $\frac{dy}{dx}-1=ge(a-x)$, and therefore by the rules of the *Integral Calculus* $y-x=ge(ax-\frac{x^2}{2})$, to which no arbitrary constant need be added, because y commences at the same point with x: if we now make $x=a$, we find that $g\frac{e}{2}.a^2$ expresses the extension of the entire string.

Similar principles may be easily applied to determine the form of an elastic string suspended from two points, and stretched by its own weight; but in this case the curve (which differs from the common catenary) cannot be considered as accurately determined without taking into account the elasticity of inflexion as well as that of extension. The mere mathematical problem may be seen in most mechanical treatises. (Price's 'Calculus,' vol. iii. chap. 5; Poisson, 'Mécanique;' consult also Lagrange, 'Méc. Analytique,' for the method of introducing the condition of elasticity in a system at rest.)

An important practical branch of this subject, on the strength of beams, which has been much advanced by Mr. Peter Barlow, and the more recent experiments of Mr. Eaton Hodgkinson, of Manchester, we reserve for a future article. [STRENGTH OF BEAMS.]

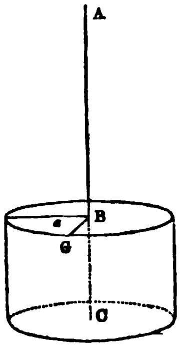
When a uniform elastic string, fixed at one extremity and stretched by a force applied at the other extremity, is abandoned to itself, it will return to its original form after a series of contractions and expansions, the force which solicits each point being proportional to its distance from its original place, though the successive oscillations go on rapidly diminishing in extent in consequence of the resistances encountered. The same law applies to the displacements of the molecules of elastic fluids and gases.

For the laws of the mutual impact of elastic bodies, see the article COLLISION, &c. If a body is attached to an elastic string, which at the other extremity is fixed, and be projected in any direction, the resolved part of the centrifugal force which acts in the direction of the length of the string tends to stretch it, and the centripetal force will be proportional to $r-c$, r being the length of the stretched and c of the unstretched string: this force is attractive when r is greater than c, and repulsive when less. Hence if we conceive a circle, of which the centre is the fixed point, and the radius equal to c, the portions of the orbit described externally to the circle are concave, and those internally are convex relatively to the centre of the circle, and there are as many points of contrary flexion [CURVE] as there are intersections of the trajectory and circle. Neither the law of the periodic times nor the form of the orbit is similar to those belonging to the earth and planets: the supposition, therefore, that attraction between the great masses which compose the solar system is conducted through the medium of interposed and invisible elastic strings is unfounded.

When an elastic string, fixed at one end, is bent by a weight or other force applied at a given point, the elasticity of inflexion acts normally at each point of the curve, and is some function of the curvature at that point. It is usual to suppose it proportional to the simple curvature. On this supposition the figure of an elastic lamina in a vertical position, fixed at its lower point, and bent by a small weight applied at the top, may be determined. This problem has been treated by Euler, Lagrange, and Poisson. The English reader may find the varieties of the elastic curve discussed in the appendix to Whewell's Mechanics.

The elastic force of a twisted string follows a law precisely similar to that of one which is only stretched: the latter is proportional to the extension, the former to the torsion. Thus, if a cylindrical elastic thread, fixed at one extremity, be twisted by a force applied perpendicularly to its length, any straight line taken along the surface of the cylinder will be converted into a helix; and with a double torsion the circular arc through which each point has been removed from its original place is doubled. And since this circular arc may be subdivided into any number of equal arcs, the successive resistances of the elasticity to the additional torsions are equal, supposing each preceding resistance to be sustained. Therefore the accumulated force of torsion is proportional to the angle through which an index would move if fixed at any point perpendicularly to the length of the cylinder, or in the prolongation of its radius: but this law has limits as well as that for the elasticity of extension; for the torsion may be continued until a strain is produced, when there will of course be an accompanying diminution of elastic force.

Let AB represent an elastic string, suspended vertically from the point A, and attached at B to a cylindrical body DE, of which the axis BC is in the direction of the string produced, the string being primitively in an untwisted state. Let the cylinder be turned round its axis through an angle FBG, or a, which measures the torsion generated in AB, and also the elastic force tending to bring the system back to its original state. Let the restraining force be now removed, and the cylinder, abandoned to itself, will return to its original place after a series of isochronous oscillations, which are gradually diminished by the resistance of the air and by the internal resistances of the molecules of AB during the processes of being twisted and untwisted.



Let δm stand for an element of the cylinder, situated at a distance r from its axis, and θ the angle of torsion, at any time after the commencement of this motion; then $-\frac{d\theta}{dt}$ is the angular velocity; and therefore the linear velocity of δm is $-r\frac{d\theta}{dt}$; the accelerating force or ratio of the increments of velocity and time is $-r\frac{d^2\theta}{dt^2}$; the force of torsion, being proportional to the angle θ, may be represented by $n\theta$ applied at a distance = unity from the axis of the cylinder, perpendicularly to the radius, the constant n being the force of torsion corresponding to an angle = unity. Now, by D'Alembert's principle, the impressed force, taken in a reversed direction, would make equilibrium with all the effective forces: that is, the force $-n\theta$, at a distance = unity, would produce an equilibrium with the forces such as $-r\delta m\frac{d^2\theta}{dt^2}$ acting on δm at a distance r; hence the corresponding moments, which are $-n\theta\times 1$, and the sum of all, such as $-r^2\delta m\frac{d^2\theta}{dt^2}$ must be equal, but of contrary signs; and since $\frac{d^2\theta}{dt^2}$ is the *common* accelerating force on all the particles δm at a unit distance, we need only take the sum of the products $r^2\delta m$, which is easily found in this case by the rules of the integral calculus, and is called the moment of inertia of the cylinder. Representing it by MK^2, where M is the mass of the cylinder and K its radius of gyration, we have the equation—

$$MK^2\frac{d^2\theta}{dt^2}=-n\theta$$

Put (for the sake of abridgment) $c^2=\frac{n}{MK^2}$; then, by the methods for integrating differential equations, we find $\theta=A\sin.(ct+B)$, where A and B are arbitrary constants; and for the velocity $\frac{d\theta}{dt}=A\cos.(ct+B)$.

Now, we can determine the constants by the circumstances of the origin of the motion; for when $t=o$, we have supposed the initial torsion was a, or FBG, and $\frac{d\theta}{dt}$ was then nothing. Hence we have $a=A\sin B$; $o=\cos B$; therefore, squaring and adding, we have $A^2=a^2$, and $A=a$. Similarly, by division, $\tan B=\infty$, $\therefore B=\frac{\pi}{2}$. The value of θ is therefore expressed at any time by $a\sin\left(ct+\frac{\pi}{2}\right)$, or $a\cos(ct)$.

When the cylinder makes half an oscillation the elastic thread is then perfectly free from torsion; and if T be the time of an entire oscillation, since θ then vanishes, we find $o=a\cos.\left(\frac{cT}{2}\right)$; therefore $cT=\pi$ and $T=\frac{\pi}{c}$, which shows that the successive oscillations are of the same duration, and that the square of the time of one oscillation varies directly as the moment of inertia, and inversely as the force of torsion, estimated at a given distance from the string.

The suspended body may be any other as well as the cylinder we have supposed, with manifestly the same results. For instance, in

Coulomb's torsion-balance it consists of a needle of gum-lac attached perpendicularly to the string, as B F in the above figure, and a small weight at B to steady the string; the law of the times of oscillation above found is sufficient to give the force of torsion in all cases if we know it in one. It is thus that Coulomb used his balance in finding the law of electrical attractions and repulsions; the electrised ball acted on, being attached to the end of the needle of gum-lac, was subjected to the joint action of electrical and elastic forces. [ELECTRICITY, COMMON.]

The range of the elastic force of fluids, in consequence of their great resistance to compression, is extremely limited, and therefore few ordinary phenomena of nature are dependent on this cause. The great pressure at considerable depths in the ocean must produce a corresponding increase of density in the lower strata, if it is not in a great measure compensated by the increase of temperature.

Water expands in volume by an increase of temperature, and contracts by a decrease; but it has this peculiar property, that at a temperature expressed by 39½ degrees of Fahrenheit's thermometer it attains a maximum of density. The quantity of water which at 60° would occupy 1 cubic foot, at 40° occupies only 0·9907 cubic foot; while at the temperatures both of 45° and 35° (its fluidity at the latter temperature being preserved by the avoidance of all agitation) the volume is 0·9991 cubic foot (Gilpin, 'Phil. Trans.,' 1792): the increase of volume at temperatures below 40° is ascribed to some tendency of the water to crystallise while it is still fluid.

The variations produced in the volume by variations of temperature, as well as the fact that water is a conducter of sound, and consequently that it possesses some elasticity, are to be considered as arguments that water may be capable of being compressed by mechanical means; but the quantities of compression which have been obtained by experiments made for the purpose are so small as to render it very difficult to determine its precise value.

In 1661 some members of the Academia del Cimento at Florence made experiments of different kinds in order to ascertain whether or not water was compressible; and one of these consisted in filling a hollow globe of silver with water at the point of freezing: an effort was then made, by blows with a hammer, to diminish the volume of the globe by altering its form, when it was found that the water escaped through the pores of the metal. The like experiment was made by Muschenbroeck in 1731 with a globe of gold, which was attended with a like result; and till the year 1762 it was considered that water was incapable of being reduced in volume by pressure. In that year Mr. Canton introduced water at a certain temperature into a glass tube, and having, by an application of heat, made the water fill the tube so as to expel the air, he sealed the tube hermetically: then, having reduced the temperature to its former value, he broke off the upper extremity of the tube in order that the atmosphere might press on the top of the column of liquid, when the height of the latter was found to be thereby diminished. The like experiment was tried with alcohol, oil, and mercury; and these fluids were found to suffer different diminutions of volume by the pressure.

It has been imagined that the apparent diminution of the volume of water was only the result of an expansion of the tube in consequence of the elasticity of the atmosphere, when the latter was allowed to enter it; but if such expansion alone had produced the effect it would have been the same, and would have caused equal depressions, in the columns of different kinds of fluid, whereas the depression of the water was about fifteen times as great as that of the mercury. There is little doubt, therefore, that the observed diminutions of height were results of the compressions of the fluids by the weight of the atmosphere.

The experiments of Canton show that, under a weight equal to that of an atmospherical column in its ordinary state (29½ inches of mercury), the compressions of the four following fluids, in millionth-parts of their volumes, and at a temperature equal to about 50°, are—

Alcohol	66
Rain-water	46
Sea-water	40
Mercury	3

The elasticity of a *perfect fluid* is such that its parts resist change of volume only, and not change of figure. The *compressibility* of a liquid is the compression produced by a unit of elastic pressure, and its *modulus* or *co-efficient of elasticity* is the ratio of the pressure applied to the liquid, to the accompanying compression, and is consequently the reciprocal of the compressibility, which latter is measured by an instrument called a PIEZOMETER. The empirical formula for the compressibility of water at any temperature between 32° and 128° Fahr. has been obtained by Mr. Rankine from M. Grassi's experiments; namely:—

$$c = \frac{1}{40(\text{T} + 461)\text{D}}$$

When c = compressibility per atmosphere required, T = temperature in degrees of Fahrenheit, and D = density of water at that temperature under one atmosphere, its maximum density under one atmosphere being taken at unity.

The elasticity of every *solid* is sensibly perfect when the strain on it does not exceed a certain limit. This has been proved even for solids like clay, for which there are limits, which, if a strain exceed, *set*, or permanent change of figure is produced. It has been shown by Mr. Hodgkinson that these limits depend on the duration of the strain, being less for a long continued strain than for a brief one, so that the elasticity of *volume* in solids is generally much more nearly perfect than that of figure. There exists one simple and uniform law for the elastic forces of dry air and all the permanent gases. From the experiments of Boyle, Mariotte, and Dalton, it is established that the elasticity, which is proportional to the pressure, is *inversely* as the volume, and therefore *directly* as the density, when the temperature is constant.

But an increase of temperature produces an increase of the elastic force of gases: or, which is the same, under a given pressure it expands the gas into a greater volume. Between the temperatures of melting ice and boiling water this increase of volume is proportional sensibly to the additional temperature, measured by a mercurial thermometer, as was well established by the experiments of Gay-Lussac; but by the more recent experiments of MM. Dulong and Petit, it appears that at much higher temperatures the degrees of the mercurial and gas thermometers no longer correspond; for the expansion of the mercury might be expected to become irregular when it tends to gassify, and therefore to have greater expansions for each degree of heat than in its liquid state.

In such experiments it is essential that the gas should be perfectly dry; for if not, the elastic force obtained will be that of dry air *plus* that of the contained aqueous vapour. For most observations on the latter we are indebted to the researches of Dalton, who observed that when the inside of a barometer is moistened, the elastic force of the vapour, occupying the space which is a vacuum in ordinary barometers, causes a depression in the column of mercury proportional to itself.

When a space is saturated with aqueous vapour or steam, the elasticity remains the same when the volume is diminished, the only effect of compression being to convert the surplus portion into water. The contrary holds generally in gases, as we have seen that their elasticity is inversely as their volume; but it is probable that with very high pressures, such as that employed by Mr. Faraday to liquefy carbonic acid gas, there exists a limit for each, beyond which it is impossible to render them more elastic by compression.

Moreover, the ratio of the elastic force of dry gas at the temperature of boiling water to that at the freezing point is by no means the same as in aqueous vapour; but at very high temperatures it seems probable that similar ratios would approximate. The following is a table of the elastic forces of the latter, corresponding to degrees of the centigrade thermometer:—

Temperatures.	Elastic Force, in inches.	Successive Ratios.
0	0·2	. . . . .
6¼	0·297	1·485
12½	0·435	1·465
18¾	0·63	1·448
25	0·91	1·444
31¼	1·29	1·418
37½	1·82	1·411
43¾	2·54	1·395
50	3·5	1·378
56¼	4·76	1·36
62½	6·45	1·355
68¾	8·55	1·326
75	11·25	1·316
81¼	14·6	1·298
87½	18·8	1·288
93¾	24	1·277
100	30	1·25

The third column is given incorrectly in Biot's '*Physique;*' and it follows from inspection that the elastic force of steam increases nearly in a geometrical progression when the temperature is increased in arithmetical; from which property steam has now become a great mechanical agent.

When vapours are mixed with each other at the same temperature and in the same space, the elastic force of the compound is the sum of the separate elasticities, provided this sum is not sufficiently great to render any of the vapours liquid, and provided these vapours have no chemical affinity.

The atmosphere which surrounds the earth is endowed with an elastic power; and partaking, moreover, of the earth's diurnal rotation, its particles should, by their elasticity and centrifugal force combined, recede from the earth till the whole is dissipated in space. Such is not the fact; and hence it is inferred, either that at a certain elevation above the surface of the earth, the elasticity of the atmosphere is totally destroyed by the absence of caloric; or that beyond the stratum in which the centrifugal force of the particles is equal to their gravitation, there may exist, in a state of rest, an etherial fluid occupying the whole extent of space, and preventing the atmosphere from being further expanded by its own elasticity.

Now, by Mechanics, it may be found, that the distance from the surface of the earth to the stratum of the atmosphere in which the centrifugal force of the particles is equal to their gravity is about five semidiameters of the earth, at which height the density must be inconceivably small; and since it is not necessary to suppose that the etherial fluid beyond the atmosphere of the earth is more dense or more elastic than the atmosphere at that height, it may readily be admitted, that whatever may be the effect of such a fluid in resisting the motion of a comet, it can produce no sensible retardation of the movements of the planets.

The crepuscular light which has been observed at the cusps of Venus, and the changes which take place on the apparent discs of Mars and Jupiter, afford indications that those planets have atmospheres, though, with our instruments such atmospheres may not be rendered sensible by their action on transmitted light. If, about a planet, an atmosphere were formed in consequence of the attraction exercised by the planet on the etherial fluid supposed to fill all space, since that fluid may have no greater density and elastic power than the atmosphere of the earth at the height of five semidiameters of the latter above its surface, the attraction of the planet may be incapable of rendering it sufficiently dense to produce any sensible effect in refracting light to the earth. Again, the height and the law of the variations in the density of the strata in an atmosphere which may be formed about a planet by the vapours arising from waters existing on its surface, would depend on the temperature; and this we have no means of knowing: but assuming it to be equal to the mean temperature at the surface of the earth, the height of such atmosphere would be very small compared with that of the existing atmosphere about the earth. An atmosphere of either of the kinds here indicated would serve to account for the rare occurrence of remarkable refractions in the phenomena of the immersions and emersions of Jupiter's satellites, or the occultation of stars by the moon.

ELATERIN ($C_{30}H_{25}O_{18}$), a vegetable principle extracted from the wild cucumber (*Momordica Elaterium*). To obtain it the evaporated juice of the fruit is to be treated with water, and the residue with alcohol of specific gravity 0·825; the solution is to be evaporated to the consistence of a syrup; the elaterin then crystallizes; more is afterwards obtained by adding potash to the mother water; the matter obtained is to be purified by means of ether. Another process consists in pouring water into the concentrated tincture of elaterium, by which the elaterin is precipitated in the state of small silky crystals.

Elaterin has a bitter and somewhat styptic taste. It is insoluble in water, and in dilute acid and alkaline solutions; it is soluble in five parts of cold alcohol and two parts of boiling alcohol, and also in ether and fixed oils. It melts at a few degrees above 212°, and at a higher temperature it is volatilised in very acrid white vapours.

Concentrated acids decompose it: nitric acid converts it into a yellow gummy mass; sulphuric acid dissolves it, and assumes a deep blood-red colour.

Elaterin acts strongly as an emetic or purgative, in doses of 1-12th or 1-10th of a grain.

ELATHIN. A chemical product of uncertain composition, obtained by acting upon acetone with sulphur and ammonia.

ELAYL. [ETHYLENE.]

ELAYL-OXALIC ACID ($C_8H_4O_6,2HO$). An acid, isomeric with succinic acid. It has hitherto been little studied.

EL DORA'DO, literally the golden country, was the name given by the Spaniards in the 16th century to an imaginary region somewhere in the interior of South America, south of the Orinoco and between that and the Amazon river, where gold and precious stones were supposed to be as common as rocks and pebbles in other countries, and to be had for merely picking them up. The first notion of this story was communicated by an Indian Cacique to Gonzalo Pizarro, brother of the conqueror, who sent his companion, Francisco Orellana, down the Amazon river to discover this wonderful land. Orellana followed the course of the Amazon down to the sea; but though he did not find El Dorado, still he countenanced the report of its existence. The temper of mind of the Spanish conquerors and discoverers of America seems to have been singularly fitted for credulous belief in all wonderful reports. The story of El Dorado continued to be accredited; a Spanish adventurer was said to have reached the capital of this enchanted region, called Manoa, and wonderful tales were told of its splendour and its wealth, far surpassing those of Peru. The Spanish governor of Guiana was also styled governor of El Dorado, because the latter country was reckoned to belong to his jurisdiction. Raleigh was so persuaded, or pretended to be persuaded, of the existence of this wonderful country, that he fitted out several expeditions for the purpose of discovering and conquering it for England; his last attempt in 1617 involved him in hostilities with the Spaniards of Guiana, which ultimately led to his death on the scaffold. [RALEIGH, SIR WALTER, in BIOG. DIV.]

ELEATIC PHILOSOPHY has its name from Elea (called by the Romans, Velia), a Grecian colony on the western coast of Lower Italy, where Xenophanes of Colophon settled in his old age (about 530 B.C.), and founded a school distinguished by its bold attempt to construct a system of the universe upon metaphysical principles. The theory was brought to perfection by Parmenides, but it also reckons among its members Zeno, Melissus, and Empedocles, who, however, only gave a further development to particular principles; the labour of Melissus being mainly confined to the defence of those positions which were opposed to the Ionian physics, while Zeno and Empedocles exhibit the opposite aspects of the theory; the former confining himself to its doctrine of the supra-sensible, the latter to a detailed application of its physiological views.

In its formation it was subsequent to the Ionian and Pythagorean schools, and was so far a consequence of them as it thought necessary to submit to investigation the legitimacy of the principles upon which they had proceeded. The problem which they had proposed to themselves was, assuming the possibility of a beginning of motion and of production and decay, to determine the first ground or grounds of all that comes into being. This assumption the Eleatæ attacked as irreconcilable with that idea of the reason which involves the law of casuality, the Eleatic expression for which was "out of non-being being cannot come," and its later and more general formula, "ex nihilo nihil;" and as no distinction had as yet been made between the efficient and material causes, they necessarily arrived at the conclusion that the world had not a beginning.

Parmenides drew a strong distinction between the ideas obtained through our reason and those derived from our senses; or between truth and opinion; but with him religious considerations predominated, and in order to refute the unworthy conceptions of the Deity to which polytheism had given rise, he showed from the very notion of God that he is necessarily one. The notion of Deity, he argued, implies his infinity and eternity, but there cannot be many infinite beings; the eternal and infinite God is therefore one. But from the denial of production it followed that the world is eternal. Now an eternal world would equally limit the eternal God: the co-existence therefore, of the two, separately and independently of each other, is impossible; consequently the world and the Deity are one. This result is the foundation of the so-called error of Pantheism; but it was only by such an error that man could arrive at a right and worthy conception of the Deity, which it is the merit of the Eleatæ to have distinctly propounded.

From the position that God or the world is one, it necessarily followed that our conceptions of sensible things singly are imperfect and insufficient to bring us to a knowledge of the All or of God. Man, consequently, is placed in a painful situation, desiring on the one hand to know God, on the other to look to individual phenomena. Attention was thus awakened to the opposition which exists between the pure truth and the sensible appearance, and the Eleatæ were the first to advance a systematic theory of human knowledge; and although its object was to deny the validity of the testimony of sense and experience, and to ascribe to the reason exclusively the merit of arriving at the truth without any attempt to reconcile appearance and reality, it nevertheless constituted a most important advancement of the philosophy of the period, and so completed its edifice as a system by contributing the dialectical or logical portion; the Ionians and the Pythagoreans having respectively constructed the physical and moral parts.

In conclusion, we must observe that the history of this as well as of the other early schools of Grecian philosophy is both obscure and imperfect, since of the written works of its several members we only possess a few and unconnected fragments. And it must be carefully observed that though Plato in his 'Parmenides,' pays a high tribute to his dialectical talents, we must not take his representation of the opinions held by Parmenides.

ELECAMPANE. [INULA.]

ELECTION (Lat. *electio*), in divinity, is a doctrine which, on the authority of Scripture, and as a consequence of the omniscient and prescient attributes of God, teaches that from all eternity the destiny of every individual of mankind was determined by an immutable decree, some (the elect) being ordained to eternal salvation, while others (the reprobate) are left to inevitable and eternal damnation. The term election is often considered as but another name for the doctrine of predestination, both implying that man is subject to a certain predetermined fate. This doctrine in modern times is associated constantly with the name of Calvin, though similar notions were maintained or opposed among the philosophical and religious sects of the ancient Gentiles, Jews, and Christians. The Essenes were believers in absolute preordination. The Sadducees rejected it, and adopted the doctrine of moral freedom. The Pharisees, in a theory of syncretism, endeavoured to reconcile and combine the two extremes. (Josephus, 'Antiq. Jud.') The Stoics insisted upon the doctrine of predestination or necessarianism; while the rival sect of Epicureans maintained that of the perfect free agency of man and the contingent nature of events. The Gnostics taught that human souls, according as they emanated from the good or bad principle, were destined to happiness or misery. In the systems of Manes (Manichæism), Marcion, Cerdon, and others of the 2nd century, similar doctrines were enforced concerning the fixed inevitable fate of men. Throughout the first four centuries the pagan philosophers, especially those of the Stoical school, opposed the dogmas and miracles of Christianity by alleging the principle of necessity as exhibited in the immutable series of causes and effects, or antecedents and consequents, in the physical and mental phenomena of nature, and the ignorant populace were confirmed believers in the influence of fortune and fatality. Justin Martyr, Irenæus, and most of the Greek fathers, in defending the Christian system, resorted therefore to arguments tending to establish anti-predestinarian doctrines. Origen, in the 3rd century, had taught that man, in his moral and religious agency, is not necessitated by omniprescient decrees of God. His tenets were adopted in Palestine, and throughout the East, especially by Chrysostom, Isidorus, Theodoret, and the other Greek fathers; and Pelagius, an English monk, proceeding on their authority, promulgated in the first half of the 5th century the sectarian theory designated Pelagianism, which asserts free agency, moral responsibility and perfectibility, making good works meritorious, and denouncing the predestinarian doctrine of imputed guilt and inherited depravity. (Pelagius in Pluquet's 'Dict. des Hérésies.') St. Augustine was among the most strenuous opponents of Pelagius, and adduced abundance of scriptural authority to show the absolute omnipotence, the omniprescience, and consequently the preordination of God, with respect to the characters and destiny of men; showing some to be elected by the divine will as objects of especial grace, and others to be abandoned to the perdition which through Adam is merited by all. (St. Augustine, 'De Gratia, De Peccat. orig., De lib. arbitr., De Dono Perseverantiæ.') The arguments of St. Augustine occasioned the formation in the 5th century of a sect in Africa called Predestinarians, the tenets of which were zealously propagated in Gaul by a priest named Lucidus, who was excommunicated and anathematised by the church in council. (See the treatise of Père Sirmond on this heresy, and the replies of the Jansenists and divines of Port Royal.)

In the 9th century, the Predestinarian controversy was revived with great enthusiasm by Gottescalque, a French Benedictine monk, who was condemned, and terminated his life in a dungeon, for teaching the "five points" concerning election, which subsequently gained for Calvin so much celebrity. Gottescalque was answered by Scotus Erigena, and many others. (Dufresnoy, 'Tablettes Chronolog.') This incomprehensible subject formed one of the great points of subtle disputation in the scholastic theology; it was discussed by 'the Angelic Doctor,' Thomas Aquinas and others, in the 13th century. Whether God's election was before or after the prevision of human merits was a standard thesis for the exercise of syllogistic skill (electio ante vel post prævisa merita). Aquinas sustained the doctrines of Augustine, and the controversy was subsequently carried on in the 16th century between his followers (the Thomists) and the adherents of Louis Molina (the Molinists). When Luther began to form his opinions, he perceived that nothing could so effectually demolish the Roman Catholic doctrine of justification by works as the predestinarian theory of St. Augustine, which he therefore enforced in his writings; but finally he was induced by Melanchthon to mitigate the rigour of his opinions concerning man's passive subjection to God's eternal decrees. By the Socinians the certain prescience of future events by the Deity is denied, and the divine decrees are maintained to be merely general, and not specially relative to particular persons. The system of Calvin is set forth in his great work entitled 'Institutes of the Christian Religion' ('Institutiones,' &c.), in which he states that "no one desirous of the credit of piety can dare to deny God's predestination of some to eternal happiness, and of others to eternal damnation;" that "every man is created for one or the other of these purposes." God having from all eternity fixed the destiny of every individual of the human race, all of whom, in consequence of Adam's offence, have been, are, and to the end of time will be, under the curse and wrath of God, and justly subject to everlasting punishment; that salvation depends wholly on God's will; that particular persons, without any regard whatever to their merits or demerits, are elected, or rejected for ever; and that God is an absolute, tremendous, and incomprehensible Judge. Such propositions, it must be confessed, are sufficiently mysterious and fearful to overwhelm the timid with despair, and excite the bold to inquire if they are founded in truth. One of the ablest works in confutation of Calvin is Dr. Whitby's discourse on the five points of his system, which are as follows: 1. God, before the creation, was pleased to choose, without prevision of merit, some of mankind to enjoy everlasting happiness, and others to suffer everlasting misery. What was certainly foreseen must certainly come to pass, as the prescience of the omnipotent and omniscient Being must be coincident with, and not by possibility antecedent to, his decrees. 2. Atonement was made by Christ only for the sins of the elect. His death did not make the salvation of all *possible*, and dependent on the performance of certain conditions; for if God intended salvation for all, doubtless all must be saved; and if Christ died for all, he died in vain for many, which is a supposition absurd and impious. 3. By original sin, that is, the imputation of Adam's guilt, all are by nature in total depravity, which justifies the consignment of the whole human race to eternal misery, and makes the election of some to happiness an act of God's especial grace and good pleasure. 4. All the elect are effectually called at some point of time in life when the influence of the divine grace is first communicated. 5. As all who are not elected must be damned, so all those who are elected must be saved: irremissible grace necessitates all their actions, and inevitable salvation must terminate their "final perseverance."

The following are some of the scriptural authorities alleged in support of these doctrines: Ephesians i. 4, 5, 11, some chosen before the foundation of the world; predestinated according to God's pleasure: Acts xv. 18, God's foreknowledge: Rom. viii. 29, 30, 33, those foreknown, predestinated, called, justified, and glorified, are God's elect; Math. xxv. 34, to inherit a kingdom eternally prepared for them: Acts xiii. 48, those ordained to eternal life believe; Rom. ix. 11, 18, 21, 22, 23, election before birth, and not according to works; God's power absolute; mercifully favours some and hardens others. Divine election is considered to be shown in the acceptance of Abel, and the rejection of Cain; in God's love of Jacob, and hatred of Esau (Malachi i. 2, 3); in the two men in the field; the two women at the mill; and the two in a bed, of whom one was taken and the other left (Luke xvii. 34, 35; Matth. xxiv. 40, 41).

Arminius, a professor in the University of Leyden, became, at the commencement of the 17th century, the chief of Calvin's opponents, who were thence called Arminians, and Remonstrants, from the remonstrance which they addressed to the Dutch government against Calvinistic intolerance. But the rigid Calvinists, headed by Goar (Goarites), being by far the most powerful party, Arminius and his adherents were condemned at the general synod of Dordrecht, convened for the purpose in 1619. (Scott's 'Synod of Dort,' pp. 112–124.) At this synod the standard points of strict Calvinism, with respect to election, were determined upon and established. That the homilies and articles of the English church, especially the seventeenth, are confirmatory of the Calvinistic views of election, is beyond dispute, though many Arminian expositors have made laborious efforts to explain away their obvious original purport. Bishop Burnet, in his exposition of the Articles, observes that the seventeenth, on Election and Predestination, "has given occasion to one of the longest, the subtilest, and the most intricate of all the questions in divinity." It displays in fact the *medulla* of Calvin's Institutes, precisely involving all the doctrinal particulars of his "five points," and asserting that, to the *elect* predestination "is full of sweet, pleasant, and unspeakable comfort; while to the *reprobate* it is a most dangerous downfall, whereby the devil doth thrust them into desperation and wretchedness." Baxter endeavoured to reconcile the doctrines of Calvin and Arminius. Arnauld, in his treatise on the subject, contends that the Calvinistic predestination directly overthrows all the principles of morality; though many others, including Dr. Chalmers, in his lectures on Predestination, assert the contrary. To enumerate the various modifications of this doctrine, which at different times have been maintained by distinguished theologians, would be endless. Some, as Origen and the Catabaptists, have denied that any one is predestined to perdition, and contended that salvation will be finally extended to every one of God's creatures, including the devil and all his angels. (Bullinger, 'Contra Catabap.') The number of writers on the subject have been very great, and are continually increasing, but the following references may be useful to the studious inquirer:—

(Cudworth's *Free Thoughts on Election;* Diderot, *Encyclop.*, articles Predestination, &c.; Bossuet, *Hist. des Variations*, liv. 14; *Westminster Assembly's Confession of Faith* (Calvinistic); Mosheim's *Eccles. Hist.*, vols. iii. and iv.; *Authentic Documents relating to the Predestination Controversy under Queen Mary*, by Archbishop Lawrence, 1819; Jonathan Edwards's *Freedom of the Will*, and other of his works; the works of Whitefield and Wesley; and the *Theological Essays* of the Rev. F. D. Maurice.)

ELECTION (law) is when a man is left to his own free will to take or do one thing or another which he pleases (*Termes de la Ley*); and he who is to do the first act shall have the election. As if A covenants to pay B a pound of pepper or saffron before Witsuntide, it is at the election of A at all times before Witsuntide which of them he will pay; but if he does not pay either before the time fixed, then it is at the election of B to sue for which he pleases. So, if a man give to another one of his horses, the donee may take which he chooses; but if the donation be that he will give one of his horses (in the future tense), then the election is in the donor.

Courts of equity frequently apply the principle of election in cases where a party has inconsistent rights, and compel him to elect which he will enforce: as, if A by his will assumes to give an estate belonging to B to C, and gives other benefits to B, B cannot obtain the benefits given to him by the will unless he gives effect to the testator's disposition to C. The principle of election is equally recognised in courts of law, though they are seldom called to adjudicate upon it, except where the alternative is very distinct, or the party has already elected. Indeed this principle is of universal application, and prevails in the laws of all countries; it is applicable to all interests, whether of married women or of infants; to interests immediate, remote, or contingent; to copyhold as well as to freehold estates; to personalty as well as to realty; to deeds as well as to wills.

Courts of equity also will compel a plaintiff suing at law as well as in equity, or in a foreign court as well as in the court in England, for the same matter at the same time, to elect in which court he will proceed, and will restrain him from pursuing his rights in all others. There are some exceptions to this doctrine, as in the case of a mortgagee, who may proceed in equity for a foreclosure, and on his bond or covenant at law at the same time; but this arises from the difference of the remedy, and from the original agreement to give the concurrent remedies: and even in such a case a Court of equity will restrain a mortgagee from enforcing his judgment at law upon the bond or covenant, if he is not prepared to deliver up the mortgaged property and the title-deeds belonging to it.

On Election under a will in the Roman law see 'Dig.' xxxiii. tit. 5, De Optione vel Electione Legata: as to the French Law, see the 'Code Napoléon,' art. 1189, &c., Des Obligations Alternatives; and for the law of Scotland, 'Ersk. Inst.,' lib. iii. tit. 3, 8, and 9.

ELECTION COMMITTEES. The trial of charges alleged on petition in respect of the election of a member of parliament, or the return made in such case to the Speaker's writ, used to be had before the house itself, and of course, became the occasion of party manœuvre and contest; but in the year 1770, the statute, known as the Grenville Act, had the effect of sending all such petitions to be tried by a select committee of members chosen upon a plan which, in substance, continued in force till the year 1839. The impartiality and justice of the system adopted in the latter year met with general approval, and continues with slight modifications to be in the main the same that is now applied in the case of controverted elections by the 11 & 12 Vict. c. 98.

The chief features of the existing system for the appointment of such tribunals are these: The Speaker at the beginning of the session of parliament, by his warrant, appoints from the members of the house, six gentlemen willing to serve, who have not been petitioned against, and are not themselves petitioners against any election, and these, if not objected to within three days from the time of the warrant being laid on the table of the house, become "the general committee of elections" for the session. Four members form a quorum, and no business may be validly transacted by a smaller number. This committee may be dissolved upon their own report, that more than two of their number are absent, or that there is irreconcilable difference of opinion among them, or upon resolution of the house for that purpose. Meanwhile, they are each sworn at the table "truly and faithfully to perform the duties belonging to a member of the said committee. to the best of his judgment and ability, without fear or favour," and to the committee thus formed are referred all election petitions, the Speaker keeping them duly informed of the state of the recognisances entered into by the petitioners, and of deaths, vacancies, or declarations on the part of members of their intention not to defend their seats.

The duty of this general committee is to appoint the committees for the trial of controverted elections, called therefrom "election committees," taking the petitions in their order from the list submitted to them, and selecting the committee from the panels framed in the following manner:

First, from the list of the house are struck the names of members exempted from serving on election committees, because they are more than sixty years of age, or because they are in high office under the crown, or for such other special reason as may satisfy the house; and also, the names of members disqualified, either because they have petitioned against a return, or are themselves the objects of such petitions.

Secondly, from the list, after it has been thus summoned, the general committee select "the chairmen's panel," consisting of eighteen, or a smaller number of members, to act as chairmen of election committees for the remainder of the session, unless discharged from their duty by the house. Vacancies created in that or in any other way being immediately filled by new appointments.

Thirdly, the residue of the general list of members is divided equally into five panels, which take order, as first panel, and so on according to a ballot conducted by the clerk at the table of the house. From these are to be chosen the members to constitute the election committees, and each panel in its own order is then, for the week, the panel that is liable to furnish members for such tribunals.

The general committee of elections having determined the time for appointing a committee to try the controverted election next in order, give 14 days' notice of the day so fixed by them. Six days before the time so fixed, the parties petitioning are required to give in a list of the voters objected to, and also of the several heads of objections on which they mean to rely in support of their petition. On the day fixed for the appointment of members, the general committee is attended by the parties and their agents; they are furnished with the names of the chairman and the four members chosen to try the matter of their petition, and with this list they withdraw for half an hour to consider what objections, if any, they have to any of the names that are upon it. It is a rule of the house that no member may serve on an election committee who has voted at the election itself, or is the person on whose behalf the seat is claimed, or is related either to the sitting member or the person on whose behalf the seat is claimed, by kindred or affinity in the first or second degree, according to the Canon law. At the expiration of the half hour, or as soon after as suits the convenience of the general committee, they return to state their objections to the list of names, and if four members of the general committee agree that the objections are well founded, the parties withdraw and the committee proceed anew to select other names for any of the four which have been struck out; or if it be the chairman that is objected to, the gentlemen forming the chairmen's panel proceed to a new election: and the same right of objecting to the new list may again be exercised by the parties who are called together *toties quoties* to signify their assent or dissent accordingly.

When an unobjectionable committee has been obtained, the members of it have notice from the committee-clerk in writing forthwith, the committee is reported to the house, and the members are bound, under peril of censure or of being committed to the custody of the Serjeant at Arms for default, to attend in their places in the house on the next sitting day at or before four o'clock, in order to be sworn at the table "we and truly to try the matter of the petition referred to them, and a true judgment to give according to the evidence."

The election committee meet by order of the house at a time fixed, within four-and-twenty hours of their being sworn to proceed with the business of their appointment, and they continue to meet daily, except on Sundays, Christmas, and Good Friday; having no power to adjourn for more than twenty-four hours at a time without leave obtained from the house for special reason, or to permit the absence of any one of their number. If one of them should nevertheless absent himself without the leave of the house, his sickness, if that is the ground, must be verified to the house upon affidavit of his medical attendant; or if it is for any other cause, that too must be verified upon oath, otherwise the defaulting member may be ordered into custody, or censured as the house thinks fit. The committee cannot proceed to business any day until their number is complete, and if it remains incomplete for an hour they must adjourn, and report the cause of it to the house; and the committee, if reduced to less than three members for three successive sitting days, is *ipso facto* dissolved, and their proceedings are void. The general committee in that case appoint a new committee to try the petition. It is always, however, in the power of the parties before it to consent to go on with a committee deficient in numbers, even when reduced to one.

These committees take evidence on oath, hear the parties by counsel, decide by a majority, the chairman always voting, and having a casting vote in case of an equal division, and their final decision is reported to the house upon the following questions: Whether the petitioners or the sitting members, or either of them, be duly returned or elected? or, Whether the election be void? or, Whether a new writ ought to issue?

A special report upon the case, or any particular feature of it, or person connected with it, such as may be the foundation of ulterior proceedings, that is, by way of criminal prosecution, or commission of inquiry, should the house deem it desirable, may be adopted by them in addition to their report on the main question before them. Until they have reported, and so become *functi officio*, even a prorogation, though it may suspend their proceedings, does not dissolve the committee.

ELECTION OF MEMBERS OF PARLIAMENT. Under COMMONS, HOUSE OF, this subject has been treated generally; but we may add here that recently several statutes have been passed directed to obtaining what is called "purity of election." The merely formal proceedings are still taken under the original Reform Acts; but in order to restrain bribery, treating, and intimidation, the returning officers are now required annually to appoint *election auditors*, through whom alone can accounts in respect of the election be paid by the candidates. Stringent provisions have been made for inquiring into charges of corrupt practices, by committees of the house, sworn to the performance of their duties. Bribery, if proved, involves the disqualification of the elector, and the unseating of the member chosen, if the charge is brought home to him. The candidate is required to appoint his own agents, in writing, so that they may be known; and to send all accounts and a note of all his disbursements to the election auditor; which, when audited and paid through the auditor, are to be published in the local newspapers. It may be added here, however, that both the method of proceeding at elections, and the principles which ought to guide legislation on that subject are at present quite undetermined, the recent Acts of Parliament being only of temporary operation and of an experimental character. (Blackstone's 'Commentaries,' Mr. Kerr's edition, vol. i. p. 166.)

ELECTORS. [COMMONS, HOUSE OF.]

ELECTRIC. Substances capable of producing electricity by friction were, in the infancy of electrical science, arranged in a class in the order of their supposed susceptibility to excitement, and were called *Electrics*, or *Idio-electrics;* while a large number of bodies, including all the metals, were supposed to be unexcitable by friction, and were hence called *Anelectrics* or *Nonelectrics*. When, however, the electric conducting power of bodies became known, it was seen that an uninsulated rod of metal, for example, could not be excited permanently, on account of the electricity being conducted away as fast as it was formed. By furnishing the metal with a rod of glass, it was found to be capable of excitation by friction, and of retaining its charge, just as a tube of glass would do. In this way it was ascertained that all solids were capable of being electrified by friction, although in different degrees, and such lists as the following were constructed to represent the order of excitability—the most excitable coming first:—

LIST OF ELECTRICS.

Shell-lac, amber, brimstone, jet.
Resins, pitch, wax.
Gums, camphor, caoutchouc, gutta-percha.
Gun-cotton, collodion paper.
Glass, and all vitreous and vitrified substances.
The diamond, agate, and most precious stones.
Tourmaline, and other crystalline, transparent, argillaceous, and siliceous gems and stones.
Bituminous substances.
Silk, dry animal furs and skins, hair, wool, feathers, paper, porcelain.
Turpentine, and various oils and fatty fluids.

Dry gases, atmospheric air, highly elastic steam.
Ice at 0° Fahr.

The substances in the above list are also called *non-conductors* or *insulators.*

The following is a list of *electrical conductors;* or, as they are sometimes called, *non-electrics.*

LIST OF NON-ELECTRICS.

Metals.
Well-burnt charcoal.
Plumbago.
Acids, acid solutions, and saline fluids.
Water, and moist vegetable matter.
Living animal matter.
Flame, smoke, steam.

The term *electric,* although having a definite substantive meaning, is, from the general love of contracting long words, often used as an adjective in the place of *electrical.* In arranging the following articles, we have consulted the reader's convenience by restoring in many cases the words to their original meaning, although in compliance with custom we shall use the expression *electric telegraph,* &c., instead of *electrical telegraph,* &c.

ELECTRICAL ALARUM. [TELEGRAPH.]

ELECTRICAL ATTRACTION. Under this designation it is intended to notice the apparent attractions and repulsions which take place when bodies are in particular states with respect to electrical power.

From a very early time it was known that amber, when excited by being briskly rubbed, seemed to draw towards it such light bodies as straws and feathers: and the phenomenon, as well as that of an apparent repulsion, is now exhibited in a more striking manner by presenting a cylinder of excited glass or of excited wax to a pith ball or a downy feather suspended by a silk line. [ELECTRICITY, COMMON.]

In attempting to explain by what means these actions might arise, it is imagined that there may exist in all material substances a fluid, or fluids, whose particles exercise upon one another attractive or repulsive powers, while a mutual attraction may take place between the fluid particles and those of the substance with which they are combined.

The hypothesis of Watson and Franklin was that there exists but one kind of such fluid: it was supposed that, in exciting glass and some other bodies by friction, the fluid was abstracted from the earth through the material by which the friction was produced, and accumulated upon the surface of the body, which thus obtained more than its natural quantity. It was supposed that this excess readily passed into any body near it, provided the latter had less than, or only its natural quantity, or at most had not so great a quantity in proportion to its magnitude. In the excitement of resinous bodies it was supposed that the fluid passes from those bodies, through the material employed in the friction, to the earth; and thus the resinous bodies were supposed to have less than the natural quantities. Hence arose the distinction between positive and negative, or redundant and deficient electricity; and the theory of Æpinus and Cavendish relating to the distribution of electricity on the surfaces of bodies is in conformity with this hypothesis. But the hypothesis is open to some objections: thus, when bodies are deprived of the fluid which, when they are in the ordinary state, is combined with them, they are observed to repel each other mutually; and it must therefore be inferred that the particles of bodies exercise upon each other a strong repulsive power, a circumstance which can scarcely be reconciled with the general attraction existing among the bodies in nature, or with the cohesive power by which the particles of all bodies are held together. It is moreover impossible to conceive, as Biot observes, why negative electricity, that is, a mere absence of fluid, should be developed on the surfaces of bodies according to the hydrostatical laws by which a real fluid would be developed.

To this hypothesis succeeded that which is now generally received. It was proposed about the same time by Symmer in England and Du Fay on the Continent, and consists in the assumption of two fluids, of directly opposite qualities, existing at the same time in combination with the particles of all bodies in nature: the particles of each fluid are conceived to exert on one another a strong repulsive force, while the particles of the unlike fluids mutually attract each other. The experiments of Coulomb with the electrical torsion balance have proved that the attractive and repulsive forces vary in intensity inversely as the squares of the distances between the particles, and that at equal distances the attractions and repulsions are exactly equal.

The manner in which the mutual actions of electrical particles produce the phenomena of attraction or repulsion in bodies with which they are combined, omitting the consideration of the effects arising from the decompositions of the natural electricities of the bodies, is conceived to depend in part on the pressure of the atmosphere, and in part on the conducting powers of the bodies. Thus, if by any excitement electrical particles be collected on the surface of two bodies (suppose two spheres) which are non-conductors, they will be retained there by the pressure of the surrounding air, and by the impermeability of the material: hence the bodies must take the motions which result from the repulsion or attraction of the fluids on them, according as those fluids are of the same or of unlike kinds. If one of the bodies be a conductor and the other a non-conductor, and they be both charged, for example, with electricity of the same kind, while that which is on the surface of the latter suffers little change of disposition, that which is on the other moves freely through its substance, and is, by the mutual repulsion of the particles, driven in abundance to the opposite side, so as to be more dense, or to form a thicker stratum there than on the side nearest to the non-conductor. But the re-action of the electrical fluid against the surrounding atmosphere being proportional to the square of the thickness of a stratum, it follows that there is an excess of force tending to make the conducting body recede from the other; and it is easy to perceive that a like explanation may be given of the contrary movement which takes place in the conducting body when the two are charged with unlike kinds of electricity. These views, however, have of late years been greatly modified, in consequence of the researches of Faraday. [ELECTRICITY, COMMON.]

The circumstances relating to the distribution of electricity on the surfaces of bodies agreeably to the hypothesis of two fluids, have been determined with the aid of a most refined analysis, by La Place, Ivory, and Poisson; and the 'Theory of Electricity,' in the 'Encyclopædia Metropolitana,' contains an investigation of the distribution on the surfaces of spheres. The results are there computed numerically, and compared with those which Coulomb has obtained by direct experiment, and the discrepancies are found to be only such as may fall within the limits of the unavoidable errors in the experiments themselves.

When a magnetised body is placed near one which is not so, a decomposition of the natural magnetism in the latter takes place, similar to that decomposition of the electrical fluids which occurs when a body in its natural state is brought near one which has been excited by friction [ELECTRICITY, COMMON], and all the phenomena exhibited by magnetised bodies on one another are capable of being explained on the hypothesis of two fluids, the particles of which repel or attract one another according as they are of the same or of unlike kinds, the intensities of the forces being inversely proportional to the squares of the distances.

The hypothesis of two fluids, moving in opposite directions, is also adopted in order to explain the phenomena of galvanism and electro-magnetism; that which is considered as positive flowing from the zinc, through the acid, to the copper, and that which is called negative, from the copper, through the acid, to the zinc; but the discovery that a balanced magnetised needle was affected when placed in the vicinity of the wire connecting the opposite ends of a galvanic battery, has given rise to an hypothesis that the power supposed to exist in what was called by the general name of an electric fluid was produced by a spiral motion of the fluid current about the conducting-wire, or about the particles of a magnetised needle.

Oersted, the discoverer of the electro-magnetic action, conceived that, when the circuit was completed by the wire passing from the zinc end to the copper end of a battery, the positive and negative fluids which, if unimpeded, would flow in straight lines, were compelled by acting against each other to move spirally about the wire; and this opinion is still generally held, it being supposed that the turns of the spiral are very near one another, so that they may be considered as circles whose planes are perpendicular to the axis of the wire. The course of either current, according to the explanation given by Mr. Barlow, may be easily understood from the following description, which relates in particular to that which is called positive: Let a conducting wire be imagined to be so bent that part of it shall be in a vertical position, and shall pass perpendicularly through the paper, the part above proceeding from the zinc or positive end of the battery, and the part below to the copper or negative end; the current of positive electricity being thus from above downwards: imagine also, a small needle whose north and south poles are represented by n and s to be horizontally balanced on a pivot and placed successively at different points in the circumference of a circle described about the intersection of the wire with the paper. Then, the directive power of the earth on the needle being neutralised by the presence of a magnet, the line $n\,s$ will assume in every part the position of a tangent to that circumference, the direction $n\,s$ being always such as it would be if the point s revolved in advance of n round the axis of the wire in the same order as the hands of a watch move. [ELECTRO-DYNAMICS.] The negative current may be understood to be revolving at the same time in like manner, but in a contrary direction. The currents thus revolving are supposed to act on the particles of the magnetised needle, disposing them to arrange themselves parallel to its axis, and so as to bring the latter in the position of a tangent to the curve described by the fluid about the wire.

The hypothesis of Ampère differs from that which has been just stated: this philosopher having formed the conducting wire into two parts, which could be so connected with the opposite poles of a galvanic battery that the current of positive electricity might be made to pass along the two parts in the same direction, or in contrary directions, found that, in the former case, the wires (which were delicately suspended in horizontal and parallel positions) seemed to attract, and in the other case to repel, one another. He from thence inferred that the fluids passed in rectilinear directions, or parallel to the axes of the wires, and that the particles were so polarised as to present to each other, laterally, when they moved in the same direction, sides which had powers of attraction; and when they moved in contrary directions, sides which had powers of repulsion: he further supposed, in order to account for the effect of the wires on a magnetised needle, that magnetic currents revolve about every particle or rather every physical point of a magnetised body, as it were in the plane of an equator to an infinitely small sphere; and he assumed that the fluid in the conducting wire of a battery exerts actions upon these revolving currents, by which the planes of the revolutions are brought into such positions that, if produced, they would pass through the axis of the conducting wire. It is evident however that the effect thus produced on the needle is the same as that which was before described; for, as the planes of the revolving currents are supposed to be perpendicular to the axis of the magnetised body, that axis must tend to place itself in the direction of a tangent to a circle supposed to be perpendicular to the axis of the conducting wire of the battery.

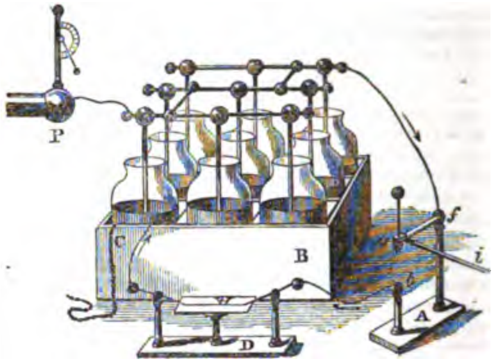
It has been ascertained that the current of electricity produced by the electrical machine causes deviations in a magnetised needle; and it is now generally believed that the electric, galvanic, and magnetic fluids, if such there be, are identical. [Electricity.] An experiment made by Mr. Faraday, in which a magnetised needle caused to float on water was found to enter a glass tube having its axis on a level with the surface and about which a galvanic conducting wire was spirally wound; while such magnetised needle would not enter the bore of a hollow magnet placed in the same situation as the glass tube—seemed however to show that the nature of the galvanic and magnetic fluids was not absolutely the same. But M. Ampère, in explanation, has observed that the result of the experiment is not inconsistent with the hypothesis of identity; since, when the wire is coiled about the glass tube, the needle is within the electric current, whereas it is outside of the currents about the particles of the magnetic tube.

ELECTRICAL BATTERY, a number of cylindrical vessels of glass, each precisely similar to the usual *Leyden jar* [Electricity, Common], the open top being covered by a plate of wood, into which is screwed the foot of a brass pillar which terminates at the top with a ball of the same metal, and at the bottom with a chain, which descends to the lower part of the jar inside; or, as in the annexed figure, the rod may be solid throughout its length, or only branch out a little at the bottom to serve as a support, in which case the jars do not require wooden covers. Both the inside and outside of each jar are lined with tin-foil to within about two inches of the top. These are contained within a wooden box, the interior of which is lined with tin-foil; a piece of wire passes through the foil and the side of the box, and carries on the exterior of the latter a ring, to which should be affixed a chain descending to the table or to the ground; or the chain may be put inside the box, as at C, in contact with the coating of one of the jars.

The ball or knob at the top of every jar is perforated, in order that it may receive one of the brass rods of a system of bars by which the tops of all the jars are connected together; the rods are terminated with brass balls, and one of these, or a ball at the upper extremity of a pillar forming part of the system, or a wire leading therefrom, is presented to the conductor of the electrical machine when the battery is to be charged. This kind of battery was first proposed by Gralath, a German, in 1747; and the manner of charging and of discharging it differs in no respect from the manner of performing the like operations with a single jar.

The quantity of electricity in a jar or battery is directly proportional to the superficies of the coating and to the degree of intensity; and the latter is in the inverse ratio of the thickness of the glass. The particles of vitreous or of positive electricity which, by the machine, are excited in the conductor, and with that on the interior surfaces of the jars, exert, through the glass, attractive powers upon the resinous or negative electricity, which by that attraction are brought from the earth to the exterior surfaces of the jars: this accumulation within the jars continues till the repulsive powers of the particles are great enough to counteract the power of the machine to supply fluid through the conductor: the charge of the battery is then a maximum. The battery is usually furnished with a pith-ball or *quadrant electrometer* [Electrometer], shown in the figure, which indicates by the amount of its divergence the progress of the charge. The discharge is made by means of a bent wire called a *discharging rod*, or by a more convenient form of apparatus known as the *universal discharger*. The power of a battery is estimated by the quantity of metallic wire which it will ignite or melt. The battery, consisting of 100 jars, which was made by Cuthbertson for the museum at Haarlem, and which contained 550 square feet of coating, ignited 655 inches of iron wire $\frac{1}{150}$ inch diameter.

The engraving represents the battery arranged for the deflagration of metallic wires. A conductor is led from the inner coatings of the jars to an insulated arm (*f*) of a discharging apparatus (A), while a second conductor passes from the insulated ball (*b*) to one of the insulated rods of the *universal discharger* (D). The wire to be burnt (W) is attached to a card supported by an insulated stand, and this wire is connected with the other rod of the universal discharger, which connects it by means of a wire with the outer coating of the battery. When the battery is sufficiently charged the lever *i* is withdrawn, when the ball *a* falls down through a hole in the metal arm *f* upon the ball *b*, whereby the circuit is completed, and the charge, passing through the whole conducting arrangement thus formed, restores the equilibrium in an instant; but the wire (W) being thinner than any other part of the discharging wire, there is a very slight delay in the passage of the charge, the consequence of which is that the enormous heating power of the electric fluid has time to act, and the wire (W) is so completely fused as to be dissipated in vapour, a portion of which leaves on the card a stain more or less characteristic of the metal.



The batteries in which electricity is excited by the chemical action of a fluid upon a metal, or of two metals upon one another, are called *Galvanic* or *Voltaic*: they are of various kinds, and will be more conveniently described under Galvanism.

ELECTRICAL CLOCK. [Horology.]

ELECTRICAL CONDENSER, a term applied chiefly to such instruments as are employed to collect and render sensible very small quantities of electricity. The principle upon which a condenser of electricity acts may be thus stated: When the electricity of any body is decomposed by being brought near another body which has received from an object in contact with it more than its natural quantity of either kind (vitreous or resinous), the fluid of that kind is repelled from the first body, and that of the opposite kind then disposes the second body to receive a new supply of the former kind from the object with which it is connected. For example, if a thin circular plate of metal, having attached to its circumference a glass handle, by which it may be insulated when held in the hand, be made to receive a small quantity of fluid (suppose it to be vitreous) from the conductor of an electrical machine with which it may be put in connection by a wire; and then a similar piece of metal, connected with the earth by being held in the hand or supported on a pillar of metal, be brought directly under it and so near as almost to touch it, the nearest surfaces of both having been covered with a thin coat of resinous varnish; the electricity of the latter plate will be decomposed, the vitreous portion (in the case supposed) flowing to the earth and the resinous portion being attracted by the fluid in the plate which is connected with the conductor to the upper surface of the other plate. This resinous fluid now attracts more of the vitreous fluid from the conductor to the under surface of the plate in connection with it, and the latter fluid further decomposes the free electricity in the former plate, thus causing in it a new repulsion of the vitreous fluid, and a new attraction of the resinous fluid to its upper surface. The like process continues till an equilibrium is produced between the vitreous fluid supplied by the conductor and the resinous fluid which is drawn from the earth.

If the plate which is connected with the conductor be now removed from thence by means of the glass handle, the fluid in it, having no means of escape, will, on the plate being presented to an electrometer, make its condensed state manifest by producing a greater effect than if the plate, while attached to the conductor, had been unaccompanied by the other plate.

Many different kinds of condensers of electricity have been constructed, and one is represented under Electricity, Common. The condensers of Volta and Cavallo are best known; but, except for some particular purposes, Coulomb's Electrical Torsion Balance [Electrometer] may be advantageously used when it is required to determine the intensity of the fluid in any body.

ELECTRICAL EGG. A glass vessel, ellipsoidal in shape, arranged so that the included air may be exhausted at the air-pump. On sending a stream of electricity through this apparatus various effects are produced, depending on the amount of exhaustion, the force of the electrical current, and the nature of the included gas. When the glass is filled with air the discharge has a white appearance; but as the air is withdrawn, the whiteness diminishes, and at length becomes violet. On increasing the intensity of the discharge, the light increases in brilliancy. When the vessel is partially exhausted, and a current produced by Rhumkorff's apparatus sent through it, the negative ball and the stem which supports the glass, become enveloped in a luminous aureola, formed apparently of several distinct beds of different shades of blue: the positive ball and a portion of its stem are also enveloped in a thin and flocculent aureola of a pinkish hue, while the space between the balls or poles, is filled with a cloud of continuous diffused reddish light. This supposed *stratification*, as it is called, of the electric light, has lately attracted a great deal of attention. It is found to be more decided if, previous to the exhaustion of the air, some vapour of turpentine or pyroligneous acid, alcohol, sulphide of carbon, &c., be introduced. In no case does the light appear to be continuous, but to consist of a succession of discharges, more or less rapid, according to the rate of oscillation of the hammer of the coil. The luminous zones appear to have a double movement of gyration and undulation, which have been regarded by some as an optical illusion, since by causing the hammer to oscillate slowly, the zones appear to be distinct and fixed. The effects can also be produced with a continuous current from a very strong battery, but an intermitting current requires only a single pair, and in this case, any increase in the power of the battery does not appear to increase the effects. M. Gaugain has endeavoured to show that the variations in the light belong to various strata of vapours contained within the glass, and that the electricity assists the arrangement of these vapours into strata.

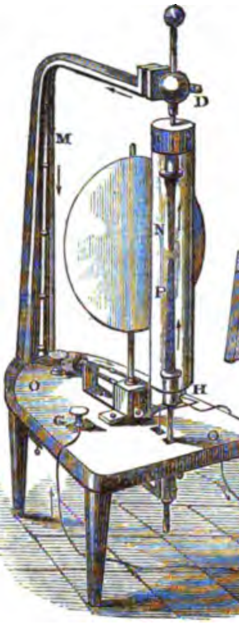
ELECTRICAL IMAGES. Under the article BREATH-FIGURES, will be found a number of curious details respecting the production of electro-graphic images or figures. Lichtenberg's figures are produced by tracing on a cake of resin any marks or figures with the knob of a Leyden jar, charged first positively and then negatively, and projecting on the cake a coloured compound non-conducting powder, such as sulphur and red-lead, triturated together. The powder will render the characters visible; because, in rubbing them up, they become electrified by the friction, the sulphur + and the red-lead —, so that when the powder is blown over the resin, the sulphur is attracted by those parts which are negatively electrified, and the red-lead to those which are positively electrified.

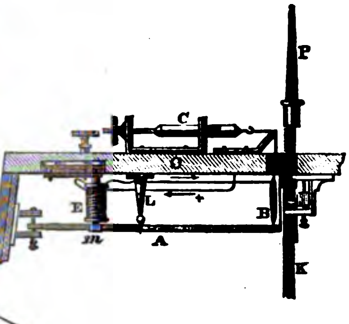
A curious class of electrical images connected with the theory of the distribution of electricity, has been investigated by Professor William Thomson, of Glasgow. The effect of an electrified body on an uninsulated sphere is represented by the image of the electrified body in the sphere. So also, when an electrified body is placed near two uninsulated spheres, an inductive effect is produced, represented by an infinite series of successive images in each sphere. If again a conductor bounded by segments of two spherical surfaces cutting at an angle which is a sub-multiple of two right angles, be electrified by induction, the effect may be represented by a finite number of images placed symmetrically in the circumference of a circle passing through the exciting or inducing body, and cutting the two spherical surfaces at right angles, similarly to the symmetrically arranged images of a kaleidoscope. Mr. Murphy, in his treatise on 'Heat and Electricity,' had previously adopted what he called "the principle of successive influences," for the purpose of obtaining numerical approximations to the state of electrified bodies influencing each other, by calculating the effects of four or five successive acts of influences.

ELECTRICAL LAMP. [ELECTRIC LIGHT.]

ELECTRICAL, or ELECTRIC LIGHT. The most splendid artificial light known is that produced by the current of a powerful voltaic battery between two pencils of hard charcoal, such as that deposited in the retorts of gas works. The charcoal, which is an imperfect conductor, becomes incandescent, and as it is not fusible at any known temperature, the splendour of the light is only limited by the power of the battery. The charcoal is formed into pointed cylinders, three or four inches in length, mounted in metallic holders connected with the ends of the voltaic battery, and the pencils are fixed, so that their points may be easily brought into contact or made to recede from each other as required. When in contact, the current passes between them, and the charcoal becomes eminently luminous. When separated, a splendid flame passes between them, and this flame is not symmetrical with respect to the two poles, for that portion of it next the positive point has the greatest diameter, and as it approaches the negative point, the diameter gradually diminishes. This light can be produced in an exhausted receiver, under water, or in gases which do not support combustion.

This light has been applied by M. Foucault with great effect as a substitute for the lime light in the gas microscope. The apparatus as constructed by M. Dubosc, and called by him a *photo-electric microscope*, contains a self-adjusting apparatus, the object of which is to preserve a nearly uniform brilliancy in the light, notwithstanding the gradual waste of the charcoal. Hitherto the difficulty has been to regulate the light so as to keep the two points at nearly the same distance from each other. The regulators of Messrs. Staite and Petrie in this country, and those of several inventors in France, were intended to produce this result. It will perhaps be sufficient if we here describe the photo-electric apparatus of M. Deleuil. It consists of a tripod of cast iron on which are fixed the two charcoal pencils and the regulator which maintains a constant interval between them. The negative pencil, N, is held by a metal support, the wire of which slides through a hole in the knob, D, with slight friction, so that this pencil once adjusted remains fixed. The positive pencil, P, on the contrary, is so arranged that in proportion as the distance between the pencils tends to increase, the action of the voltaic current causes it to rise. The regulator by which this result is attained is attached to the lower part of the tripod, but is represented on a larger scale in a separate figure, for both of which we are indebted to the 7th edition of M. Ganot's 'Traité elementaire de Physique,' 1857. A is a lever attached at one end to a spiral spring B, so that it can oscillate upon the pivot L through a very small space, the other end being fixed between the points of a vice, capable of being adjusted at pleasure. Now this lever tends to turn in one direction by the action of the spring, B, and in a contrary direction by the action of an electro-magnet, E.





At the end of the lever near B is a steel spring, the upper end of which, at I, is engaged in the teeth of a ratched bar, K, on the top of which is a holder of the positive pencil P. Now it is evident that when the current circulates with full force through the wire of the electro-magnet, the latter strongly attacks the iron armature, *m*, attached to the lever, A, whereby the arm of the lever to the right of L descends through a small space, and causes the steel spring, I, to slip into one of the lower teeth of the ratchet bar. This motion does not cause the ratchet bar to descend, since the upper part of the steel spring is curved in such a way as to exert no resistance in descending, but only in ascending. If, however, the distance between the pencils P and N increase, the electrical current becomes weaker, the electro-magnet loses somewhat of its attractive force, and not being able to counteract the action of the spiral spring, B, the latter draws up its end of the lever, and with it the steel spring, I, the effect of which is to raise the bar, K, a quarter of a millemètre. No sooner are the charcoal points brought nearer together, than the current resumes its former intensity, and the electro-magnet acts as before, the steel spring slips into a lower tooth ready to raise the bar when the current becomes enfeebled by the increased distance caused by the wasting away of the charcoal points. The screw at C is for regulating the spiral spring, B. In both figures the direction of the current is indicated by arrows. The charcoal points are preserved from the cooling action of the air by being enclosed in a tube of glass, and a metallic reflector allows the light to be directed and concentrated at any required spot.

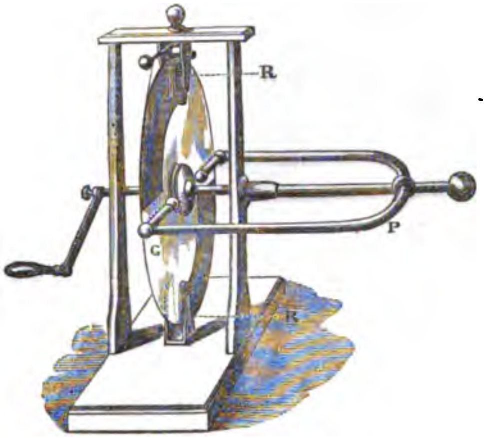
Now that the electric light has been brought under control, it is of course a question of expense, as in the case of electro-motive apparatus, whether we shall employ our coal in smelting the metals which are to be burnt in the voltaic battery, for procuring a source of illumination, or whether our coal may not be more economically employed in generating street gas. This light has been employed in France to give light to the workmen employed at night in excavating the docks at Cherbourg; two sets of apparatus were used, each maintained with one of Bunsen's large batteries of 50 pairs, and these were sufficient to give light to 800 workmen, at the total cost of 14 francs 55 c. for each apparatus. The light has also been employed by night in certain public works in Great Britain.

MM. Fizeau and Foucault have endeavoured to compare the electric light with that of the sun, by means of the chemical effects produced by each source on plates of iodide of silver. Taking the intensity of the solar light at midday at 1000, the electric light from 46 pairs of Bunsen, was represented by 235, while with 80 pairs it was only 238. The intensity of the light, in fact, does not increase with the number of pairs, but with the extent of surface. With three series of 46 pairs each, arranged so that all the positive poles should meet in one, and the negative poles also in one, the effect of which was to triple the amount of surface, the intensity was 385, or more than one-third that of solar light. Bunsen found that 48 pairs not arranged for producing the greatest effect, yielded a light equal to the united effect of 572 wax candles.

The electric light determines the combination of a mixture of chlorine and hydrogen, and acts on chloride of silver in the same manner as solar light. When passed through a prism, a spectrum is produced which differs in some respects from the solar spectrum; but in the case of the electric light, the spectrum varies with the material of which the electrodes are composed.

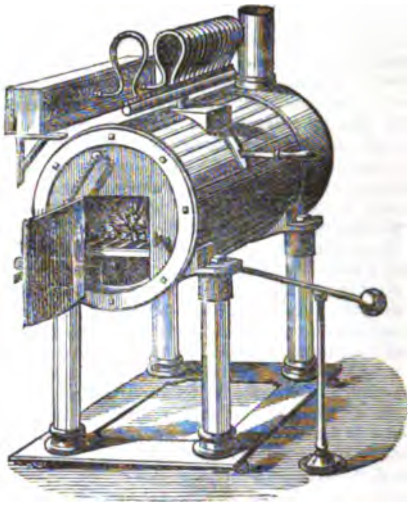
The light produced by the magneto-electric machine [Magneto-Electricity] has lately been applied to the illumination of lighthouses. The South Foreland lighthouse, near Dover, is thus furnished. The lighthouse is placed on a high cliff, and the light is visible at the distance of above 27 miles, and can be seen from the lanterns of the lighthouses of the coast of France.

ELECTRICAL MACHINE. An apparatus for furnishing supplies of electricity. There are two principal forms of this instrument in general use, namely, the *cylinder* and the *plate* machine. The former will be described under Electricity, Common; the latter, in its simplest form, is represented in the annexed figure. It consists of a disc of plate glass, G, moving upon a central horizontal axis with two pair of rubbers or cushions, R, grasping the plate, proceeding from which are flaps of oiled silk, also attached, by means of threads, to fixed points, to prevent the plate from dragging them too much: P, is the prime conductor, insulated by means of a glass stem. When this machine is in good order it furnishes an abundant supply of vitreous electricity. A method of insulating the rubber so as to obtain negative electricity has been contrived by Sir W. Snow Harris, and is described in his 'Rudimentary Electricity.' Plate machines of great power have within the last few years been erected in London; that at the Polytechnic Institution was 7 feet in diameter, and was turned by a small steam engine, while that at the Panopticon, in Leicester Square, was 11 feet in diameter.



A good deal of attention has lately been excited by a new method of mounting plate machines, invented by Winter, of Vienna. There is only one pair of rubbers, and they are large and peculiar in shape; but the most curious feature of the machine is a stem rising vertically from the prime conductor, and carrying at its top a large wooden ring lined within with metal. The effect of this new arrangement is greatly to increase the striking-distance of the sparks; but then it must be borne in mind that the sparks are less frequent than in the ordinary plate machine. This method of mounting does not, *cæteris paribus*, increase the quantity of electricity, but only the size of the sparks and their striking distance. Some of the Edinburgh instrument makers have adopted this method of mounting, but the London makers do not seem disposed to favour it. The reader interested in the subject will find a full account of the method, with figures and measurements, in the second edition of Frick's 'Physikalische Technik,' Braunschweig, 1856, p. 348.

The *Hydro-Electric Machine* is a powerful source of electricity. It originated in 1840, in the observation of a workman who was in charge of a fixed steam-engine at Sighill, near Newcastle. A leak in the cement about the safety valve led to a considerable escape of steam, and the engine-man, in attempting to adjust the weight of the valve, noticed a strong electric spark proceeding from the metal-work of the boiler, and from the boiler itself, if he attempted to touch it while steam was escaping, especially if one hand were immersed in the vapour. Mr. Armstrong (now Sir Charles), of Newcastle, examined the phenomenon, and by means of an insulated brass rod, with a metallic plate at one end and a ball at the other, the former being immersed in the escaping vapour and the latter held near the boiler, sixty or seventy sparks per minute were obtained. Armstrong's hydro-electric machine was based on this result. It consists of a steam-boiler insulated on stout pillars of glass, and of a large number of bent iron tubes, terminating in wooden jets, through which the steam issues with considerable force: projecting from the boiler is a conductor, terminating in a knob, while immediately in front of the jets is a metallic case, containing several rows of points for receiving and carrying off the opposite electricity of the steam, for if it were allowed to return upon the boiler the electrical forces would be neutralised. Faraday has shown that the electricity produced by this machine does not depend merely on the issue of steam through small orifices, nor on any chemical or physical change due to evaporation or condensation, but is the result of the friction of the condensed particles of water which are driven by the steam through the jets, which particles act the part of the glass plate in the common machine, and give out vitreous electricity, while the wooden jets and pipes act as rubbers and give out resinous electricity. In fact the friction of the steam is the source of the electricity; the escaping steam exhibits positive and the boiler negative electricity: it is remarkable that a small quantity of oil or of turpentine in the exit pipe reverses these electrical states. Wood seems to be the best material for the orifice of the jet; ivory one of the worst.



Another electrical apparatus depending on friction is the Electrophorus, and will be described under that head.

Rhumkorff's *Magneto-electric induction coil* is a powerful source of electricity, but the proper place for its description will be found under Magneto-Electricity.

ELECTRICAL, or ELECTRIC TELEGRAPH. [Telegraph.]

ELECTRICAL TIME BALL. [Time Ball.]

ELECTRICITY. A subtle imponderable agent pervading all matter apparently without affecting its volume or temperature, and without displaying its presence in any way when in the latent state; but when excited, its effects may be displayed either in a *sudden*, violent, and destructive manner, or as a less energetic but *continued* force. The remarkable differences in the numerous and varied phenomena of electricity depend chiefly on the modes in which the force is developed, whether by mechanical power or by chemical action, by magnetic or calorific influence, or in certain cases by the animal will. Thus when the force is excited by means of friction, as with the ordinary electrical machine, it is called Common or Frictional Electricity, or in honour of one of the great investigators of this branch of knowledge, Franklinic Electricity. A second modification of electricity is Magnetism, which like common electricity is a polar force, operating on every description of matter, but commonly exhibiting its properties in bars or needles of steel known as *magnets*. The third branch of electrical science is due to chemical action, as when two dissimilar metals are brought into contact in a liquid which acts upon one of them, in which case there is developed an electric current known as Galvanism, or Voltaic Electricity, in honour of the founder and great improver of this branch of science, namely, Galvani and Volta. Fourthly, there is Thermo-Electricity, in which a current is produced by the action of heat upon certain metallic arrangements. Fifthly. Certain fishes, such as the torpedo and the electrical eel, are furnished with an apparatus capable of producing electricity, which for distinction's sake, is termed Animal Electricity. The influence of an electric current on the magnet, or the magnetic relations of the voltaic current, present a large class of important phenomena which are included under Electro-Magnetism, while the electrical phenomena produced by magnetism form the branch of science known as Magneto-Electricity.

Science does not now pretend to explain why electricity is capable of being excited from its neutral condition by any of the means above indicated, any more than the mode of its existence in matter. She does not pretend to decide whether electricity be a material agent, or only a property of matter, or whether, like light and heat, it is supposed to be due to the vibrations of an ether. For the sake of convenience, however, electricity is assumed to be a physical agent, having the properties of an elastic fluid, and hence capable of being held in equilibrium by the mutual action and re-action of antagonistic forces, or of moving in definite directions and forming currents of greater or less intensity. Hence the modes of investigation and the method of classification have had reference to the mechanical sciences, the varied phenomena of electricity being included in one or other of the great divisions ELECTRO-STATICS and ELECTRO-DYNAMICS. In the first of these the electric fluid is regarded in a state of equilibrium or repose, and the phenomena of stationary charges and the laws of excitation and discharge are also studied; while in the second division, which is much the more extensive of the two, the laws of continuous discharge, or of electric currents, are chiefly considered.

Although the electric force is greatly modified by the mode in which it is excited, yet the phenomena are so far related as to suggest the idea of a common principle. Frictional electricity is eminently distinguished by its *tension*, or power of overcoming resistance, which enables it to strike through air from one conducting surface to another, and to discharge itself with great facility from points, whereas the electricity of a powerful voltaic battery, owing to its low tension, has no striking distance either through air or in an exhausted receiver. Frictional electricity passes readily through rarefied and heated air and through flame. In like manner, the voltaic discharge will take place through heated air, as when the charcoal points of the poles of a powerful battery are gradually separated after contact. With a very powerful apparatus the discharge has been thus made to pass through 4 inches of air, and in an exhausted receiver through 6 or 7 inches. Common and voltaic electricity have remarkable heating powers, and in this respect magneto-electricity is not deficient; but neither thermo- nor animal electricity has as yet exhibited heating power. The magnetic powers of all the electricities are strongly marked, especially those of voltaic electricity: all in like manner deflect the magnetic needle, and all have the property of imparting magnetism to steel. Common and voltaic electricity, especially the latter, effect numerous chemical decompositions. Water has been decomposed by the electricity of the torpedo, and also by magnetic action, as well as by thermo-electricity. The shock produced by common and by voltaic electricity becomes painfully exalted when imparted by magneto-electricity. By means of thermo-electricity the limbs of a frog have been convulsed; and the severe shocks given by the torpedo and electrical eel are well known. The spark common to the frictional, voltaic, and magnetic fluids has been obtained from the torpedo. From these and other points of comparison the identity of the five kinds of electricity seems to be made out, the differences of intensity and quantity being sufficient to account for their supposed distinctive qualities. Faraday has further strengthened the belief in their identity by showing that the magnetic force and the chemical action of electricity are in direct proportion to the absolute quantity of the fluid of whatever intensity which passes through the galvanometer. Thus the electric phenomena, connected as they are by well ascertained laws, form the most complete and important addition to the physical sciences that has been made since the time of Newton.

The most important treatise that has been published of late years on all the electrical forces is that by De la Rive, in three large volumes, a translation of which has been published by C. V. Walker. This work contains copious lists of authoritative memoirs; but it should be stated, that the views adopted differ in some important particulars from those of English electricians.

ELECTRICITY, COMMON, FRICTIONAL or FRANKLINIC.

The simplest and most usual mode of producing electricity is by friction. When any two substances are rubbed against each other briskly it is always produced; but it is only a particular description of bodies called *non-conductors* that retain it after it is thus produced so as to exhibit its primary effects of *attraction* and *repulsion*.

The production of electricity may be observed in a very familiar manner thus: Tear up a piece of paper into small fragments, and place them on a table; then take a stick of sealing-wax, and rub it briskly with a piece of flannel, or against the sleeve of a cloth coat, and immediately after hold it near the fragments of paper; these small pieces will be soon observed to be agitated and the smaller to fly with considerable velocity to the wax, to which having adhered for some time, some will suddenly jump off, others which have touched the stick edgeways will dangle from it for a considerable time, and then fall off by their own gravitation when the electrical force has sufficiently subsided. It was by observing that amber produced similar effects after friction to those we have described that electricity obtained its name (ἤλεκτρον, amber).

Glass is now more commonly employed to produce electricity than wax or gum; and there is a striking difference in the kind of electricity then generated, which we shall afterwards notice more at length. These bodies are non-conductors, as they manifestly retain their electricity beyond the moment of its production, and they are *isolators* or *insulators*, because a conducting substance will also retain its electricity when communication with the earth, or with other conducting substances, is cut off by means of non-conducting supports or envelopes.

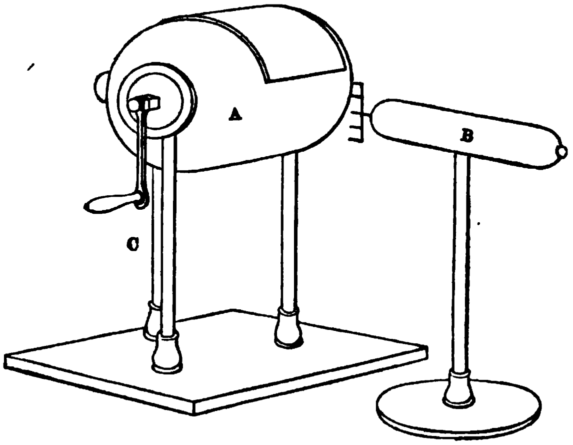
Water is a conductor of electricity; for if we immerse a conducting insulated and electrised substance in water, it will be completely deprived of its electrical properties. Perfectly dry airs or gases, on the other hand, are non-conductors; for if not, none of the phenomena mentioned could have been observed, as the experiments are not made in vacuo. We are not aware that it has yet been established whether the vapours of all substances are conductors (or all the gases non-conductors). Aqueous vapour certainly is a conductor; and therefore, when the air is impregnated with moisture, it is difficult to perform any electrical experiments which require duration. [ELECTRIC.]

Hence a conductor constitutes a channel by which the electricity produced on a non-conductor will escape, and a non-conductor constitutes an insulator by which the electricity communicated to a conductor may be retained. Thus, if we place an electrified glass tube on a tin stand, the metals being conductors, the electricity will be gradually dissipated; on the contrary, if we place an electrised tin cylinder on a glass support in dry air, the electricity will be retained for a long time.

Nevertheless it is far from improbable that this is a question only of degree; that all substances are conductors; and that the usual terms conductor and non-conductor strictly mean quick conductor and slow conductor.

When an electrised body is brought near the skin where the power of touch is delicate, a sensation is produced which has been compared to that produced by the touch of a cobweb; but instruments founded on the laws of electric action have been constructed, which indicate the presence of electricity in its most feeble state, and measure its tension. [ELECTROMETER.]

Previous to our study of the properties of electricity, on which the construction of the best machines for procuring it in large quantities depends, it will be useful to describe a simple apparatus, and one easily constructed or procured, by which we may learn the first laws of electrical action.



A represents a glass cylinder of which the axis is supported on a frame, and which is pressed against by a cushion stuffed with horsehair, and covered by an amalgam of zinc, tin, and mercury ground up with lard and spread over its surface; this cushion is mounted on a glass rod C, but attached to the cushion is a metal chain communicating with the table or the ground. At one extremity of the axis of the cylinder is attached a handle by which it may be rapidly turned round, and the friction which is generated against the cushion will produce electricity on the surface of the glass, to guard which against the action of the moisture of the air, the upper side of the cylinder may be lapped over by a piece of glazed taffeta in the direction of the rotary motion of the cylinder. B is a long narrow and hollow metallic cylinder standing on a glass support, and having at the extremity near A a small cross bar garnished with points or teeth presented towards the cylinder. B is called the *prime conductor* in this apparatus, or *cylinder electrical machine* as it is called. When the cylinder A is turned briskly round, the motion will be accompanied by a crackling noise, and in the dark, streams of light of a yellowish or bluish hue will be perceived directed to the several points on the projecting bar of the conductor. B may be thus *charged* with electricity, and when removed from the presence of the cylinder (taking it away by its insulating support), it will retain its electrical properties (the longer as the air is more free from moisture), and will by simple contact communicate a portion of its electricity to another isolated conducting substance, or be discharged by touching one not isolated: if, with a feeble charge, it be touched by the finger, a sensation like the pricking of a needle will be felt, accompanied by a faint spark apparently penetrating the fingers.

It is useful to cover the glass supports at their points of contact with gum-lac, which is an excellent insulator.

Glass plates are now in more general use than cylinders for the production of electricity by friction. [ELECTRICAL MACHINE.] Perhaps the most perfect apparatus for producing electricity, and also measuring its quantity, is that employed by Sir W. Snow Harris, and described in his 'Rudimentary Treatise on Electricity.'

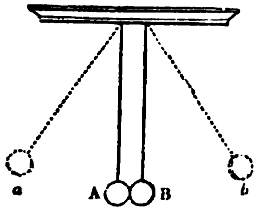
We shall now observe, as our first phenomenon, that neither the cylinder which has generated and given out electricity, nor the conductor which has acquired it, exhibits the least alteration of weight, nor will the greatest possible accumulation of electricity produce the least perceptible alteration in this way. Those who suppose that electricity is a distinct species of matter, an all-pervading fluid, have therefore denominated it *imponderable*. Facts do not, however, authorise us yet to take this view of it, or to regard it as essentially different from the forces which the molecules of matter exercise, which, though neutralised for external bodies when these molecules are in positions of equilibrium or stability relative to their mean places, may become sensible by impressed forces, such as friction, which would alter the position of their poles, or by sudden concussion forcibly altering their relative situations. There is a convenience of language, however, in speaking of electricity as a *fluid*, which can lead to no error by its adoption until the phenomena of molecular action have been more studied, and the views of Mosotti and many other natural philosophers with respect to the identity of these forces better established. [ATTRACTION.] Adopting, therefore, this hypothesis, the sense in which we speak of its quantity, its accumulation, its density, or its partition between bodies, may be readily translated into the hypothesis founded on the views of molecular action if we should find any occasion for it.

The next phenomenon to be noticed is the limit to the quantity of electricity which we can communicate to a perfect conductor. If, from different sources of electricity, we charge a metallic ball, and so continue to charge, we shall find that there is a limit beyond which we cannot communicate more; for on attempting so to do, the ball will discharge itself through the air into the nearest conducting body, when a spark, describing apparently a zigzag course, will be observed, the colour of the light being dependent on the medium which it traverses. This spark travels with immense velocity (as will be noticed more particularly hereafter), and is accompanied by a very audible sound; and if received by the body of a man or animal, it produces through a part or the whole of the system an instantaneous muscular contraction, which may be rendered sufficiently strong to cause death, but in more moderation has been used in some diseases, such as deafness, though its use has become by no means general, and indeed the curative effect is very doubtful.

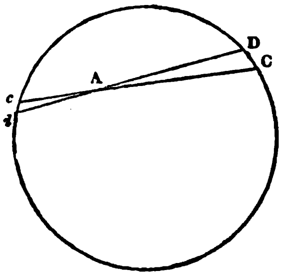
Two points determine this limit, or fix the charge of which a perfect conductor is susceptible. The first is the extent of its surface; for if two bodies have similar figures, the quantities of electricity of which they are capable are proportional, not to their solid content or weight, but to their surfaces; that is, to the square of their linear dimensions. The second is the pressure of the non-conducting medium by which they are encompassed.* The quantity of electricity is then as the square root of the pressure. When placed in an artificial vacuum, an electrical light is observed along the sides of the machine. Harris has shown that dry air, considerably rarefied by the action of the pump, will suffice to retain the electricity of a body for a long time; but it should be remembered that the square root of two quantities gives a much lower ratio than the quantities themselves; and this ratio cannot be considered very small in any artificially-formed vacuum.

That the quantities of electricity should follow the law of proportionality to the surfaces, and not to the content or weight of the body, will not excite surprise when it is stated that no developed electricity exists within a body, at least to any appreciable depth below its surface. This fact has been repeatedly confirmed by experiment; and in consequence of this law we see the advantage of using a long cylindrical form for a conductor, and perceive the proportions in which the partition of electricity takes place when several similar conductors communicate.

We come now to the third and very important phenomenon of the mutual repulsion of the different parts of developed electricity: these parts repel each other with forces which vary inversely as the square of the distance. We may easily witness this repulsion in the following familiar manner. Take a small well-dried ball of elder-pith, and suspend it from the hand by a fine silk thread, which is a good non-conductor; then bring it near the conductor of an electrical machine, or to a body to which this conductor has communicated electricity. The ball will at first be attracted to this body; but when it has touched it and shared a small portion of its electricity, it will be repelled from it and will stretch the string by which it is suspended in a slanting direction, until the obliquity is sufficiently great for its own gravity and the tension of the string to counterpoise the repulsion of the electricity on the conductor. Let two pith balls be suspended by parallel strings so as to touch each other, as A, B, and if a portion of electricity be communicated to them by temporary contact with a body already charged, the strings will diverge in consequence of the mutual repulsion, and the balls will come into the positions *a*, *b*, where, notwithstanding their gravitation, they will remain a considerable time, if the air be very free from moisture. They will be observed gradually to close in towards each other as they lose their electricity from the contact of the surrounding medium.



That the law of force in this case is, as in gravitation, expressed by the inverse square of the distance, was satisfactorily demonstrated by Coulomb by means of his torsion balance, the principle of which we have before explained [ELASTICITY], and has been confirmed by Harris's experiments: and a remarkable fact arises from it, namely, if the electrised pith-ball A be placed any where within the concavity of a spherical shell, it will not be moved in any direction by the repulsion of the electricity on the surface of the shell; for the electricity being then uniformly distributed, the intensity of the force of any small portion D C is at its extent, or proportional to the square of the arc D C, and is therefore destroyed by the action of an opposite portion *d c*, cut off by a conical surface having A as vertex, and D C as base; for $DC^2 : dc^2 :: DA^2 : cA^2$, that is, what the portion gains in extent it loses in its distance from A. This law was first demonstrated by Newton ('Principia,' book 12), and it was afterwards shown by other analysts, that for no other law of force but that stated could the same mutual destruction of forces occur (Laplace, 'Mécanique Céleste,' tom. i., liv. 2; Murphy's 'Electricity,' chap. iii.); and Poisson, from other considerations which we shall afterwards notice, made this condition, for a body of any figure, the ground of his calculations on the distribution of electricity over the surfaces of bodies.



When electricity is produced, as above described, and a conductor charged, if the conductor be removed, and another conductor replace it, the latter will become charged by repeating the operation: thus the cylinder, and indeed every substance properly mounted, is an inexhaustible source of electricity.

We have supposed the cushion by which the cylinder is rubbed to be in communication with the ground by means of a conductor; but if two substances both isolated be electrised by friction, and when separated the electricities belonging to each surface be examined, we find the following results:—

Let two insulated pith-balls, A and B, as before, be electrised by communication with one of the surfaces, and two other balls *a b* in like manner electrised by the other surface. Then when A is presented to B, or *a* to *b*, repulsion takes place as before described; but when A is presented to *a*, or B to *b*, they will attract each other; and if A, *a* have equal charges from the different surfaces which have been rubbed against each other, when contact takes place between A and *a*, all signs of developed electricity will depart from each, and the bodies will take their natural positions, neither attracting nor repelling each other; but if A has a greater electrical charge than *a*, a surplus of the electricity of A will remain, and will be partly communicated to *a* when a consequent repulsion arises.

The same results would occur if two machines were used, in one of which the cylinder is glass, and in the other resin or a gummed substance: the pith-ball which receives its electricity from the glass cylinder will attract that which has been in communication with the other machine. 2

Hence arise the terms *vitreous* electricity and *resinous* electricity, or, as they are also called, *positive* electricity and *negative*; for whatever two substances they may be which are rubbed together when electricity is produced, it will be found positive on one substance and negative on the other, even if the substances are of the same nature; for instance, both glass. [It is necessary, however, that the two surfaces be in different physical states, such as one rough and the other smooth, or heat, not electricity, will be the result of the friction.]

The phenomenon above noticed may be then announced as follows: "Like electricities mutually repel, unlike mutually attract;" and the law of force between particle and particle is in both cases the inverse square of the distance.

Moreover, we have seen that the addition of quantities of unlike electricities is similar to the addition of quantities with unlike signs in algebra: when equal the sum is zero, when unequal it is the excess, and of the same name as the greater charge.

Franklin's theory makes only one electric fluid in excess above its natural state in bodies positively electrised, and in defect in those said to be negatively electrised. Epinus, and most of the continental philosophers after him, suppose the existence of two distinct electrical fluids, the particles of each of which repel those of the same kind, but attract those of the contrary, and therefore the opposite electricities always seek combination or neutralisation, so that in natural bodies the two fluids exist in equal quantity, by which the presence of neither is indicated. Mosotti has in some degree revived the theory of Franklin in his memoir on the forces which determine the state of bodies. [ATTRACTION.] We adopt at present the theory of two fluids, but all the phenomena may be readily expressed also on Franklin's theory.

---

* This idea of pressure has been considerably modified since the adoption of Faraday's views, which will be stated further on.

The pressure of the electricity on the surrounding medium, when the body is perfectly conducting, determines the direction of the motion under the influence of foreign electrised or non-electrised substances, which, by rendering this pressure unequal on the different parts of the surface, produce motion by the unequal reaction of the medium. But imperfectly conducting bodies have in themselves a certain retentive or coercive force, and the electrical particles, instead of then freely obeying the external impressed force by a corresponding law of arrangement or accumulation amongst themselves, communicate the forces impressed to the particles of matter by which they are restrained. In imperfect conductors the force is partially exercised in each of these ways. The circumstances of the motions of electrised substances therefore vary with their conducting faculty.

We can now understand the mode in which light substances are attracted to a stick of sealing-wax which has been made electrical by friction; the electricity of the wax is in this case negative; and when brought near a small piece of paper, which is a conductor, it acts upon the neutral fluid of the paper, attracting some of its positive electricity to the side next it, and forcing the negative to the farther surface, which, being in communication with the ground or a conductor, is carried off; so that the paper is thus *by influence* made positively electrical, which, being of a contrary kind to that of the wax, is attracted by it, and therefore the paper flies to the wax, and having touched it communicates its positive electricity to it, thereby neutralising a portion of its free fluid; after which it shares a part of the surplus of negative electricity remaining on the wax, when it is of course repelled; and if it become neutral by again touching the ground, and the electrical force has sufficient energy, it will again fly to the wax and the same results will be repeated.

When a body is of an irregular figure, and is electrised, the electricity of its surface will be differently accumulated at the different parts, projecting points having the most, and portions of small curvature the least in convex surfaces; and it is a mathematical problem of considerable difficulty in some cases "to find the law of the distribution of free electricity on the surface of a perfectly conducting body of a given form." The datum for the solution is, that the whole action of the electric envelope on any point interior to the body is zero: we have shown that it would be so in the case of a sphere by a uniform distribution on the surface: but in other bodies this distribution cannot be uniform to produce the same effect. The next case in the order of simplicity is the spheroid, or more generally the ellipsoid, for a spheroidal shell, bounded by two similar and concentric spheroidal surfaces, and attracting by the law of the inverse square of the distance, will exercise no action on an internal point; hence the accumulation of electricity on the surface of a spheroid at any point is proportional to the normal breadth of the stratum at that point, which it may be easily proved is proportional to the perpendicular drawn from the centre on the tangent plane, or inversely as the diameter parallel to the tangent at that point.

Hence we see why the accumulation of electricity at points is so great, which are therefore part of the armature of prime conductors; for if we conceive the axis minor of an ellipse to diminish indefinitely, while the axis major remains invariable, the breadth of the spheroid generated will be correspondingly diminished while the length remains the same, and ultimately it will approximate to the form of a needle pointed at the extremities of its axis major, the breadth of the electricity at the point is then to that at the middle of the needle as the length of the needle is to its greatest breadth. Now, in consequence of the law of force being the inverse square of the distance, we find the pressure against the air is as the square of the accumulation, and consequently is very much greater at either extremity of the needle than at or towards the middle; and therefore, on being overcharged, the electrical spark is given from the extremity, when not otherwise determined by the influence of external bodies.

Moreover, when several conducting bodies, some or all of which are electrised, are placed near each other, a new distribution of electricity takes place on their surfaces, caused by the decomposition of the neutral fluid of each by the action of the extraneous substances: thus, the principle for calculating the distribution in this case on every body is to suppose it such that the total action on any point within each of the conductors shall be zero; for if not, the neutral fluid at that point would be decomposed, and the separated fluids proceeding to the surface of the body would alter the distribution. When the distribution is ascertained, then the motions of the bodies may be calculated according to the laws of dynamics, the pressure against the surrounding medium being as the square of the accumulation.

Two spheres placed in contact and electrised will have the point of contact neutral. This result of theory (founded on the principles above detailed), with many others, has been fully confirmed by experiment. Those who wish to follow up the mathematical principle here noticed, may see Poisson's 'Memoirs on Electricity' ('Mémoires de l'Institut'). and an English treatise expressly on this subject by Mr. Murphy of Cambridge. We may however here introduce a few popular details on the subject, chiefly with reference to the distribution of electricity or the densities of the electric fluid in different bodies placed so as to act electrically upon one another, or in different parts of the same body when the latter had been subject to the electrical influence of another body.

When a body possesses equal quantities of the opposite kinds of electricity, the fluid may be conceived to be uniformly diffused through it; and two such bodies being placed in contact, will produce no effect on each other, because the attractions existing between the particles of the unlike fluids are counteracted by the equal repulsions between the particles of the like fluids. But if a body acquire by any means an excess of either the positive or negative fluid, a mutual action will take place between this body and any other in its vicinity, the fluids in the latter being previously in equilibrio or not.

It was early found that two electrified spheres, equal in magnitude, but of which one was solid and the other a thin shell, acquired precisely equal quantities of the electric fluid; and hence it was inferred that such acquired fluid existed only upon or near the surface of an electrified body. The experiments also of Franklin on a charged Leyden jar with interior and exterior coatings, which could be removed and replaced at pleasure; and those of Coulomb, in which, by a proper apparatus, electricity was drawn from the surface of a charged body when none could be obtained from the bottoms or sides of holes sunk in it to certain depths, sufficiently prove that the electric fluid exists in a stratum on the surface or rather within the body at an infinitely small distance from the surface.

If a sphere have uniformly diffused over its surface a charge of either kind of electricity, and there be placed in contact with it a sphere of equal magnitude in which the electric fluids are in equilibrio, a mutual action between the spheres will take place; the effect of which will be that the fluid particles of opposite kinds in both spheres will have their equilibrium disturbed, and equal quantities of both kinds will flow to the surface of each: the density of the fluid, or the thickness of the stratum at either surface, being different in the circumferences of circles at different distances from the point of contact.

The investigation, by mathematical analysis, of the laws of the distribution of electricity being too extensive for this place, it must suffice to state the results of some of the experiments made by Coulomb on that subject.

When a sphere, charged as above supposed, is placed in contact with another in which the fluids are in equilibrio, whatever be the ratio between the diameters of the spheres, the density or the thickness of the stratum of fluid on each is, at the point of contact, equal to zero; and, at the opposite extremity of the diameter passing through that point, the density is the greatest. Representing the density opposite to the point of contact by unity, the results of the experiments with two equal spheres show that, in an indefinitely narrow zone at thirty degrees from the point of contact on each, the density may be represented by 0·2; at sixty degrees from that point, by 0·76; and at ninety degrees, by 0·95: it is found also that the mean density on each sphere is represented by 0·79.

When two spheres, in the circumstances just mentioned, but having the diameter of one double the diameter of the other, are placed in contact, the experiments of Coulomb show that, on the smaller sphere, the density opposite to the point of contact is, to the density at ninety degrees from that point, as 1 to 0·75; and at sixty degrees, as 1 to 0·44: they also show that, at ninety degrees from the point of contact, the density on the smaller sphere is to the density on the larger as 1 to 0·8; and that the greatest density on the smaller sphere is to the mean density on the greater as 1 to 0·64. When the diameters of the spheres were to one another as 4 to 1, it was found that the greatest density on the smaller sphere was to the mean density on the greater as 1 to 0·43.

If two spheres which have been placed in contact are subsequently removed beyond each other's influence, the density of the fluid at the surface of each becomes uniform; but on the larger sphere the density is always greater than on the smaller sphere. From Coulomb's experiments it is found that when the diameters of the spheres are as 2 to 1 the densities are as 1·08 to 1; and when the radii are as 4 to 1 the densities are as 1·3 to 1. That philosopher infers also from his experiments, that in no case can the ratio of the densities on two unequal spheres be greater than that of 2 to 1.

When an electrified globe and a circular disc were placed in contact, Coulomb found that the quantities of fluid on them were directly proportional to their entire surfaces. The distribution of electricity on the surface of a spheroid has already been noticed.

When electricity is generated by the friction of two substances, one acquires positive, the other negative electricity, but it is difficult to judge *à priori*, from the nature of the substances employed, the character of the electricity which each will take; and though most treatises contain tables of substances in which each is positive to that which precedes and negative to the succeeding, yet the nature of the electricity is so liable to alteration, from very minute circumstances of the friction, that it is better, even in each case, to try direct experiment. The friction produced by liquids also produces electricity, the electric light, when a barometer well freed from air is first filled with mercury, having been remarked from the earliest dates of the use of that instrument [BAROMETER]; and we have seen in the case of the hydro-electric machine [ELECTRICAL MACHINE], that water in the form of small drops acts as the *rubber*. So also when a current of air is directed against a plate of glass, the latter will acquire positive electricity, and therefore the air negative, and the rapid agitation of a piece of silk in the air communicates to the latter positive electricity while the silk acquires negative.

The difference of temperature of a substance often determines the species of electricity which it acquires by friction. Generally an increase of temperature disposes to negative electricity, and polish or smoothness to positive; pressure on many crystals will produce opposite electricities, as will also heat (as in tourmaline), and even the slight adherence which a piece of glazed taffeta would have to an isolated metallic plate which it covers is sufficient to give the plate negative electricity, which is the more remarkable from the fact that the friction of the two would have made the taffeta negative and the plate positive.

Moreover, both the electricities are produced in most of the chemical compositions and decompositions, in the sudden fracture of substances, in evaporations, &c.; and the higher couches of the air are in a state of positive electricity when unoccupied by clouds, which are found indifferently charged with either. [ELECTRICITY, ATMOSPHERIC.]

When a body is positively electrised, we can procure the negative electrisation of another conducting substance by the influence of the former on the neutral electricity of the latter: this is what is understood by *electrical induction*. Let the conductor be placed in the vicinity of the influencing body, but not so close as to receive any positive electricity by sparks or other direct communication. The natural electricities of the conductor will be then separated by the influence of the positively electrised body, towards which the negative electricity must be attracted and the positive repelled; the part of the conductor nearest the influencing body must therefore be covered with negative electricity, and that more remote with positive. If, now, this end of the conductor be made to communicate with the ground, the positive electricity will escape into this great reservoir, and moreover sufficient negative electricity will be communicated from the ground to the conductor to render the point of contact neutral: thus the conductor acquires a double charge of negative electricity, and when isolated will be found negatively electrised after it has been removed from the vicinity of the isolating body.

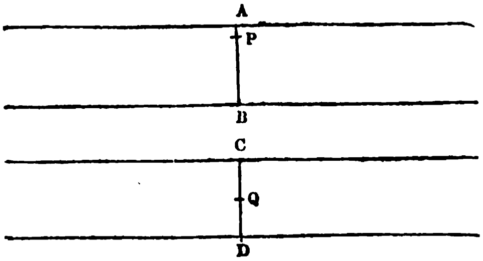
The effects of influence or induction, as above described, may be easily observed in the following manner: Place a long and narrow insulated conducting cylinder before a body strongly electrised, and from different equi-distant points of the cylinder suspend pairs of pith-balls by cotton threads, which will acquire the electricities of the parts of the cylinder with which they are connected. We shall observe a considerable divergence in the pair suspended nearest the influencing body, because they are strongly charged with an electricity of a contrary nature to that of the body: going along the cylinder, the divergence diminishes, and at a point not as remote as the middle of the cylinder there will be no divergence. Beyond this neutral line the cylinder has an electricity of the same kind as the influencing body, increasing in intensity towards its farthest extremity, and therefore the strings commence to diverge more and more as we approach that end. In making this experiment a single pair of pith-balls moved along the cylinder will be sufficient if we secure them from the direct influence of the body by a piece of glass interposed near them.

This is the direct influence which the electrised body has on a neutral body, very different from the methods of developing electricity by excitation and communication already referred to. Here is a charged body exerting an inductive action on an insulated cylinder, and developing on it not merely one electricity of an opposite kind to itself, but equal quantities of the two electricities. We shall return to the phenomena of induction presently, in order to point out some of the results obtained by Faraday and the modern electricians: but having now seen the action of an electrised on a neutral body, we may remark that the neutral body must again re-act on the original body, sensibly decomposing its electricity if it be a conductor; and thus the true arrangement of the electricity, in two surfaces influencing each other, although instantaneously effected, may be regarded as the final effect of a succession of direct and reflected influences between the bodies. [ELECTRICAL IMAGES.] This principle has been shown by Mr. Murphy materially to facilitate the actual calculation of the distribution of electricity on two electrised surfaces in presence of each other.

The effect of the influence of a near electrised cloud has been felt by several persons, among others by the writer; and in many cases fatal results have followed, not from the direct discharge of the electricity, or, as it is called, the *lightning*, but from the sudden re-union of the electricities which had been separated by influence, and which, upon the discharge of the cloud, is effected by means of a corresponding electric charge brought through the body from the ground.

From the power of separation of the neutral fluid in bodies at a distance which is exercised by electricity, an easy means has presented itself by which a much greater quantity of electricity may be collected upon a conducting plate than that which could be directly communicated by a conductor. We shall therefore now endeavour to explain the principle of the condenser, which we think is very inaccurately stated in Biot's 'Physique,' in which the subject of electricity is treated, generally speaking, in a very luminous manner.

The following investigation the author of this article gives, on his own responsibility, with the desire of placing the power of the condenser on its true basis:—



Suppose two equal conducting plates, of which the axes are A B, C D to communicate respectively at A and D with known sources of electricity, and have their opposite faces B, C, near to each other and parallel, the whole being surrounded by a non-conducting medium, the known sources of electricity communicate quantities E, E′ of electricity to the bases B, D, and the mutual influences of the system generate other quantities X, X′ on the second bases B, C, these quantities are dependent on E, E′, on A B, C D, which for simplicity we shall suppose both equal to c, and on the mutual distance B, C of the plates, which we shall call a. Our problem is to find X and X′ from these data.

Consider the total action on a point P, taken anywhere within the first plate and on its axis; this must be equal to zero, in order that the neutral electricity at that point may not be further decomposed. Let $PB = z$.

The action arising from the base A and the adjoining portion of the sides of the plate included between A and a parallel drawn through P is $E f(c-z)$; the form of the function f is unknown, since it depends on the law of the distribution of the fluid at the different parts of the base and sides.

Similarly, the action arising from the base $B = X f(z)$
.. .. $C = X' f(a+z)$
.. .. $D = E' f(a+c+z)$.

Our first equation of condition must therefore be—

$$X f(z) + X' f(a+z) - E f(c-z) + E' f(a+c+z) = o \; \ldots\ldots (1);$$

and if we consider in precisely the same way the equilibrium of a point Q within the second plate and in its axis, we obtain (putting $CQ = z'$)—

$$X' f(z') + X f(a+z') - E' f(c-z') + E f(a+c+z') = o \; \ldots\ldots (2).$$

The equations (1) and (2) must hold true for all values of z and z' between o and c, and they serve to determine the form of the function and the values of X, X′.

If the bases were infinite, $f(z)$ would be constant. ('Principia,' book xiv.)

Now $f(z) = f(o) + f'(o) \cdot z + f''(o) \cdot \frac{z^2}{1.2} +$ &c. by Maclaurin's Theorem $:= f(o)\left\{1 + n\frac{z}{c}\right\}$ nearly; for z being very small, we reject the powers higher than the first, and put $\frac{n}{c}$ for abridgment, instead of $\frac{f'(o)}{f(o)}$; c is introduced for homogeneity.

We may observe that n is necessarily a very small fraction in the actual case; for it depends on $\frac{c}{R}$, R being the line[illegible] dimension of the base, and it vanishes when R is infinite.

The equations may be thus simplified; and dividing them by $f(o)$ they become—

$$X + X'\left(1 + \frac{na}{c}\right) - E(1+n) + E'\left(1 + \frac{na}{c} + n\right)$$
$$+ \frac{nz}{c}(X + X' + E + E') = o \; \ldots . (3)$$

$$X' + X\left(1 + \frac{na}{c}\right) - E'(1+n) + E\left(1 + \frac{na}{c} + n\right)$$
$$+ \frac{nz'}{c}(X + X' + E + E') = o \; \ldots . (4).$$

Hence by subtraction and dividing by $\frac{na}{c}$, we obtain—

$$X' + X + (E' - E)\left(1 + \frac{2c}{na} + \frac{2c}{a}\right) + \frac{z - z'}{a}(X + X' + E + E') = o \ldots (5).$$

Since $z - z'$ may be positive, negative, or zero, and yet this equation always true, we must have separately—

$$\left.\begin{aligned} X' - X &= (E - E')\left(1 + \frac{2c}{na} + \frac{2c}{a}\right) \\ X' + X &= -(E + E') \end{aligned}\right\} \begin{aligned} &\ldots . (6) \\ &\ldots . (7) \end{aligned}$$

It will be useful to make a few remarks before proceeding further.

The expression which we have put for the action of the plane C on P in equation (3) is in reality the action not only of that plane, but also of the side of the prism or cylinder, of which the base is C and altitude CP; and a similar remark applies to the action of the plane D: therefore the total action given in that equation is too great by twice the action of the side of the prism or cylinder included between the plates B and C. For the same reasons we have a like excess in the equation (4); wherefore we have subtracted these equations, when that excess disappears; whereas, if we had added them, an error would arise, small with respect to X and X', but comparable to $E + E'$.

Also, from equation (7), the apparatus would be discharged by making the two plates communicate.

In the actual case the lower plate communicates with the ground; therefore $E' = o$.

Adding now the two equations, we find—

$$X' = \frac{cE}{a}\left(1 + \frac{1}{n}\right),$$

and subtracting—

$$X = -\frac{cE}{a}\left(1 + \frac{1}{n} + \frac{a}{c}\right).$$

n is a very small quantity and negative, since the attractive force diminishes as the point acted on becomes more remote. Hence X is very great and positive compared with E, and it follows:

First, that the greater the extent of the plates, the less n will be, being zero when that extent is infinite; therefore the power of the condenser is increased by the extent of the surfaces being enlarged.

Second, that another source of increase of the condensing power is the diminution of a, the space occupied by the non-conducting medium interposed between the parallel conducting plates.

These results are perfectly accordant with experience.

In practice, the conducting plates are generally separated by a plate of glass or a cover of varnish, the latter being used when the electrical charge is feeble; for the attractive forces of the two opposite electricities $X\,X'$ would be too powerful for such an obstacle if E were great, and the electricities would penetrate it and unite; but in chemical operations, where the electricity developed is of weak tension, the diminution of a is of great advantage, the quantity of electricity acquired by the plates becoming very sensible to the electrometer. [ELECTROMETER.]

The Leyden jar is an instrument founded on these principles. A glass bottle is coated within and without with tin-foil. The conductor of an electrical machine communicates with the foil on the inside by means of a metallic chain, while the outside is in communication with the ground. The opposite electricities are therefore accumulated on the internal and external sides of the glass: hence a flash and a powerful shock is produced, when the two fluids combine, by touching the outside foil with one hand while the conductor or chain communicating with the inside is touched by the other.

It was ascertained by Cavendish that the quantity of electricity produced in the Leyden jar, with given surfaces, was inversely proportional to the breadth of the glass; this completely corresponds with the results which we have above obtained by theoretical considerations.

There seems little doubt, from the experiments of Wollaston, that much of the electricity produced by the common machine is attributable to chemical action; for the best amalgam to use with the rubber is that which oxidises most readily, such as tin and zinc; and scarcely any quantity of electricity is produced if, by the nature of the amalgam, there is no sensible oxidation, or if we envelope the apparatus in a medium which will not communicate oxygen, as carbonic acid gas. As the quantity [illegible]n by the conductors is proportional, *cæteris paribus*, to their surfaces, it is usual to employ several narrow cylindrical conductors placed parallel to each other; the total surface in this case being the same as that of a single cylinder of the same length, and of which the radius would be the sum of all their radii.

The electrophorus is founded on a principle nearly similar to that of the condenser; but in this case it is the non-isolated body which acquires electricity by the influence of that which is isolated.

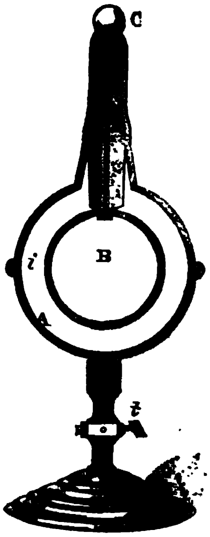
It should be observed, that the non-conducting plates employed in the condenser and Leyden jar have a certain retentive power on the electricity, and which is of the same origin as its non-conducting faculty: hence it will happen generally in experiments that the whole of the electricity will not be discharged at once, when the opposite electricities of the two plates are made to communicate by a conductor, and frequently not after several repetitions. The same principle of the separation of the neutral electricity of remote bodies by influence is observed in the electrical machines which have been at different times constructed. [ELECTRICAL BATTERY; ELECTRICAL MACHINE.]

In the best conducted experiments there will be a loss of electricity, arising either from the hygrometric state of the atmosphere, or the imperfect insulation of the supporters employed. When, for instance, the moist particles of vapour floating in the air come in contact with the conductor of an electrical machine, they acquire by their own conducting power a small portion of the electricity developed in the conductor; being similarly electrised they are repelled; and new particles of moisture arising, repeat the same process of exhaustion, each tiny robber carrying away as much electricity, not as it can hold, but as it may hold without being itself held. The quantity thus lost in a small given time is proportional to the whole charge, and therefore the latter must diminish in a geometrical progression when the time increases in arithmetical.

The reviser of the above masterly article (which was furnished by the late Robert Murphy to the 'Penny Cyclopædia') has been unwilling to do more than modernise a few of the terms and erase a few lines on subjects which the present state of electrical science required to be treated of at greater length under separate heads. It is now proposed to add some brief particulars of the admirable labours of Faraday in this branch of science, referring those who desire further information to his numerous papers published in the 'Philosophical Transactions' during the last twenty years, but collected into three volumes entitled 'Electrical Researches,' 1838—1858.

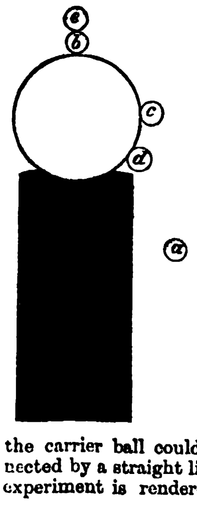
The theory of electrisation by influence did not take into account the medium which separated the excited body from the one acted on. It was said, for example, that an electrified cloud would throw a corresponding portion of the earth's surface into a negative state independently of, or at any rate without reference to, the interposed air, which was supposed to remain passive during the action of the force, and then to oppose by its non-conductibility the union of the opposite electricities. The experiments of Faraday, however, have led to the conclusion that it is only by means of the interposed air or other non-conducting medium that electrisation by influence is possible; that there is no electric action at a distance greater than the interval between two adjacent molecules of the medium; that there takes place in this medium a true polarisation of the particles, or a separation of their opposite electricities, whereby they become arranged into an alternate series or succession of positive and negative points or poles; and that it is by means of this polarisation of the particles that the force is transferred to a distance. So long as the particles of the medium retain this state of polarisation, insulation continues; but if the forces communicate or discharge one into the other, an equalisation or combination of the opposite electricities takes place throughout the whole series of particles. Faraday assumes that all the particles of matter are more or less conductors; that in their quiescent state they are not polarised, but become so by the influence of contiguous charged particles, in which case they assume a forced condition, and tend to return by a powerful tension to their original normal condition. Such particles being regarded as more or less conductors, they communicate their charge either bodily or by polarity, and contiguous particles impart their forces more or less readily to each other: when less readily, the polarised state becomes more exalted, and insulation is the consequence; when more readily, conduction results. Induction may therefore be defined as the action of a charged body upon insulating matter, the particles of which communicate the electrical forces to each other in an extremely minute degree, whereby they become polarised and propagate an equal amount of the opposite force to a distance. According to this theory, therefore, a charge is not retained on an insulated conductor by the pressure of the air, as was formerly supposed, but in virtue of the inductive action of surrounding surfaces through the polarisation of the interposed medium. It is a question of action and re-action: the insulated ball charged + produces an opposing but equal amount of — electricity, just as when we pull against a fixed point, that point offers an equal amount of resistance in the contrary direction.

The property possessed by the particles of matter to transmit the electric influence is termed *inductive force*, or *specific inductive capacity*; and this is found to be different in different insulating media. In order to compare them, the apparatus here represented in section was contrived. It consists of two metallic concentric spheres (A B), the space between the two (*i*) being destined for the reception of the substance whose inductive capacity was to be measured. The inner sphere is suspended by means of a metal rod, terminating at the top in a brass knob (C), and the rod is coated with a thick mass of shell-lac (*s*) to insulate it and separate it from the outer sphere. This is formed in two halves, like Madgeburg hemispheres [AIR], while a stop-cock (*t*) and a tube allow the air of the large sphere to be exhausted, and different kinds of gas to be let up into the interval: when solid media were introduced they were cut to the required shape. Two sets of apparatus were made, identically alike, for the sake of comparison. The apparatus was in fact a kind of Leyden jar, in which the two conducting coatings could be separated at pleasure by means of any required non-conducting medium. Now we know, in the case of a charged Leyden jar, that if it be made to communicate by its knob with the knob of an uncharged jar of precisely the same size, the latter will take from the former exactly one-half of the charge. Moreover, if we touch the knob of a charged jar with a small insulated conductor, such



as a gilt ball of light wood suspended by silk, or with a disk of gilt paper attached to a stick of resin and called a *proof plane*, it will take away from the charged jar a quantity of electricity of the same tension as that of the charge, and by this means the tension can be measured by a delicate electrometer. Now, in Faraday's first experiment, the interval *i* in both cases contained air, and the outer sphere was uninsulated. The small knob C being electrified, the inner sphere became charged, and the tension of the free electricity on its surface was measured by touching C with a proof plane and then trying it with a torsion electrometer. In this way a torsion of 250° was obtained, representing the tension on the sphere B. On bringing the ball C into contact with the corresponding ball of the second uncharged apparatus, the tension on the inner sphere of each apparatus became 125; or, in other words, the electricity had become equally distributed in the two instruments, as was to be expected, seeing that they were identical in make, and both contained air in the interval *i*. On filling up the lower half of this interval with a non-conducting body, such as a thick hemispherical cup of shell-lac, charging the other apparatus in which the interval, *i*, contained air as before, and measuring the tension on B, the number 290 was obtained. On dividing the charge between the two instruments there was no longer an equal division of the charge as before, such as $\frac{290}{2} = 145$, but the apparatus in which the interval contained air, gave a tension of 114 only, and the other apparatus with the shell-lac a tension of 113. Taking these numbers as equal, they differ considerably from 145, or half the charge, had both instruments contained air, and it appeared that whilst in the division the induction through the air had lost 176° of force, that through the shell-lac had only gained 113°. If this difference be assumed to depend entirely on the greater facility possessed by shell-lac, of allowing or causing inductive action through its substance than that possessed by air, then this capacity for electric induction would be inversely as the respective loss and gain indicated above, and assuming the capacity of the air apparatus as 1, that of the shell-lac apparatus would be $\frac{176}{113}$, or 1·55. Corresponding effects, in the reverse order, were obtained when induction through shell-lac was converted into induction through air, the force or tension of the whole being increased. As one-half of the interval contained air, this number would be too low to represent the specific inductive capacity of shell-lac. Other substances were tried in a similar manner, and they gave different values. One remarkable result was, that gases have the same inductive capacity, and that this is not modified either by their temperature, or by their pressure or their hygrometric state. Expressing, therefore, the inductive capacity of air by 1, the following numbers (obtained by Snow Harris by a totally different mode of experiment) represent the different substances named:—resin, 1·77; pitch, 1·80; yellow wax, 1·86; glass, 1·90; sulphur, 1·93; shell-lac, 1·95. Faraday has proposed to call these isolating bodies *dielectrics*, in contradistinction to conductors, which have no inductive power, that is, induction is not possible through conductors in communication with the ground.

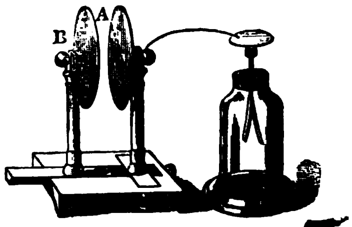
It has been urged as an objection to Faraday's theory that induction takes place in vacuo; but unless it can be shown that the most perfect vacuum which can be produced contains absolutely no material particles, the objection falls to the ground. Indeed it is a consequence of Faraday's theory that the fewer the particles of the dielectric the stronger is the charge or ultimate result. Nor does there appear to be any limit to the distance of the action. We have seen Faraday trace it from an electrified insulated ball placed in the middle of the theatre of the Royal Institution to the walls of the room.



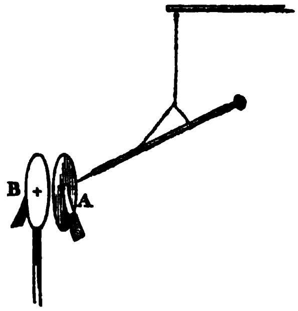
Seeing then that inductive action takes place through the particles of intervening matter, Faraday supposed that such influence was exerted, not in the direction of straight lines only as had been previously assumed, but also in curved lines. To test this opinion a cylinder of shell-lac, about an inch in diameter and seven inches long, was fixed in a wooden support; it had a concavity at the upper extremity for supporting a brass ball. The upper half of the cylinder was excited negatively, the brass ball was placed on the top, and the arrangement examined by means of the carrier ball and the torsion electrometer. When the carrier was made to touch the ball the two were uninsulated by touching them with the hand, then insulated as before, separated, and the charge of the carrier examined. In this way the force was found to vary in different positions. When the carrier was placed at *d* the effect produced was 512°, at *c* 270°, at *b* 149°; when not touching the brass ball at all, as at *a* and *e*, it was electrified also +, as in the other cases, and at *a* gave the highest result, or over 1000°. The charges obtained at *a*, *c* and *d* might arise from an inductive action in straight lines, but that at *b* was clearly in a curved line, since the carrier ball could not, from the size of the brass ball, be connected by a straight line with any part of the excited shell-lac, and the experiment is rendered still more decisive by placing the ball at a distance, and obtaining a discharge of positive electricity after uninsulating and then insulating it. If, instead of the ball, a brass plate be placed on the shell-lac, uninsulated, the carrier ball will show signs of electricity at various distances at the side and above the plate.

In good conductors the polarisation of the particles must, according to this theory, take place, but the discharge from particle to particle occurs so instantaneously, that they can only exhibit the polarised state as a whole, as in the case of an insulated sphere. Now it is evident that this result is brought about whether the body be solid or hollow, since the charge will be found only on the surface of conductors, for it is there only that the surrounding air or other resisting dielectric medium exists, and on this medium does the power of maintaining induction and consequently charge on the part of the insulated electrical body depend. The early electricians were not a little puzzled at finding no traces of electricity within a hollow insulated electrified conductor. Thus Priestley ('History of Electricity,' p. 688), says, "I electrified a tin quart vessel standing upon a stool of baked wood, and observed that a pair of pith balls insulated by being fastened to the end of a stick of glass, and hanging entirely within the cup, so that no part of the threads were above the mouth of it, remained just where they were placed without being in the least affected by the electricity." Many of Faraday's experiments beautifully illustrate the fact of the accumulation of the charge on the outside. For example, if an ice-pail be insulated and a brass ball also insulated be electrified and introduced into the vessel so as to touch it, and then be withdrawn, it will be found to have given up the whole of its charge to the pail. If now we introduce the proof plane, or the carrier ball into the vessel, no electricity will be carried away, but on touching the outside a full charge will be obtained. There can evidently be no charge within the vessel because there is no object towards which induction can take place. If, however, an uninsulated brass ball be held within the pail but without touching it, the particles of air will immediately become polarised, since the brass ball can assume an electrical condition opposite to that of the pail: the proof plane can then take away a charge from the interior as well as from the exterior of the vessel. If the pail be + the ball will be —, for its + electricity will pass to the ground along the conducting wire.

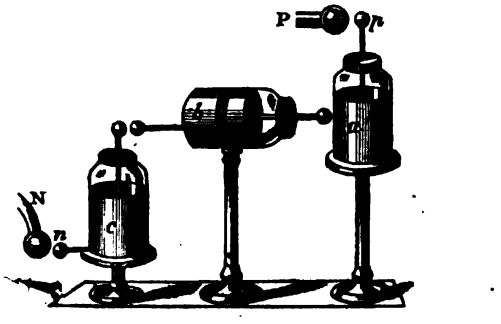
According to the new theory, the action of the condenser is thus explained:—If an insulated metal ball be charged and placed in the centre of a hollow sphere, induction will diminish in every direction as the square of the distance. If an uninsulated conducting surface be introduced, the induction will be diverted from distant objects, and the more so the nearer the conducting surface is brought to the charged ball. The surface will be electrified in an opposite state to that of the ball, and the fewer the intervening particles of the dielectric air, the stronger will be the polarity in them, and the more completely will induction be drawn off from distant objects. The tension of the interposed air may become so great that it ceases to insulate, and a discharge takes place between the two surfaces, manifested by a spark: for example, let a metal disk A insulated on a glass pillar, be connected by a wire with a gold-leaf electroscope, and a small charge of + electricity be given to A, so as to cause the leaves to diverge; if now a second metal disc B, uninsulated, be made to approach A, the gold-leaves will gradually collapse, but will open out again if B be withdrawn. This will take place a number of times, an effect which could not be explained by the old theory of a charge being retained by the pressure of the air. Now the action of the charged disc A is to decompose the electricity of B, to retain upon it an equivalent portion of — electricity, while the + electricity of B passes off to the earth. In consequence of this latter action the disc A may receive a considerable charge by repeated contact with a body very feebly charged, the excitation being renewed after every contact with A: during this time the plate B must be very near to A, and if B be suddenly withdrawn, the gold leaves will diverge, because the whole induction is now directed upon surrounding objects, instead of being limited by B.



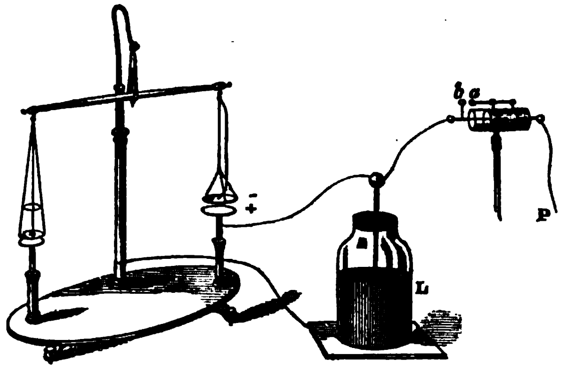
The opening out of the gold leaves in the above experiment by what is called electrical repulsion, is due to induction, for no electricity can be detected on the inner surfaces of the leaves, but only on the outer surfaces, as may be proved by substituting slips of gilt paper for the gold leaf, and when diverging under a charge, bringing a proof-plane into contact with them, and testing it by means of a torsion electrometer. The leaves diverge because induction takes place from their outer surfaces towards surrounding objects, which attract the leaves and cause them to separate from each other. If, however, an uninsulated body be placed between the leaves, induction takes place from the inner surfaces towards it, and they collapse. Every case of attraction is preceded by induction, for the opposed surfaces become oppositely electrified by polar action, and then attraction is possible. This may be shown by one of Harris's beautiful experiments, in which a disc of gilt card, A, three inches in diameter, is balanced at the end of a light rod of shell-lac and suspended by a thread. At the back of the disc is attached a slip of gold-leaf, and a similar insulated disc, also with a slip of gold-leaf at its back, is charged, say +, and brought up to the disc A, when it will be seen that the gold-leaf on A will open out, and then, and not till then, will the disc A be attracted to B.



The Leyden jar is an example of a solid dielectric between two conducting surfaces. A plate of glass partially coated with tin-foil would serve the purpose, only it is not so convenient a form as a jar. The glass should be thin, and the coating of tin-foil, both within and without, should extend to within two or three inches of the neck, the upper part of the jar being left uncovered, in order to insulate the two coatings. Through a wooden cover passes a wire, surmounted by a brass knob, and terminating in a brass chain for conveying the charge to the inner coating. On connecting the knob of the jar with the prime conductor of an electrical machine in action, bright sparks will pass from the conductor to the knob; the electricity passes down the wire, and by means of the inner metallic coating distributes itself over the interior of the glass, the particles of which become polarised, and thus decompose the electricity of the outside of the jar, leaving it in an opposite state. The electricity of the same name passes from the outer coating to the earth, so that it is necessary for the outer coating to be uninsulated. If the jar be insulated, as at *a*, only a feeble charge can be introduced into it, but if a conductor be held near the outer coating of the insulated jar, a spark will pass from the outer coating for every spark that strikes upon the knob, *p*, of the jar. In this way a number of jars, *b*, *c*, &c., may be charged by connecting the knob of one with the outer coating of the jar nearest to the prime conductor, P, of the machine, and the knob of the third jar *c*, with the coating of the second, *b*. In this way each jar may receive a powerful charge, although all be insulated except the last in the series, the outer coating of which must communicate with the earth, or a conductor, N, in communication therewith. It will be evident, however, that a charged jar does not contain a larger quantity of either electricity than it does in its neutral condition; only there is a different distribution of the force: in the uncharged jar the compound electricity is equally distributed within and without the glass; while in the charged jar, the electricity of one kind is accumulated on the interior, and that of the other kind on the exterior of the glass. That the charge is on the glass, and not on the coatings, may be proved by making the coatings moveable, when the jar can be charged, and the glass be separated from its coatings, and restored to them again without disturbing the charge. That the intervening glass or dielectric is molecularly polarised is proved by a good experiment by Matteucci: a number of thin plates of mica were placed one upon the other in a pack, and metallic plates being applied to the other pieces, the whole was charged like a Leyden jar. On separating the plates by means of insulating handles, each was found to be electrified, one side being positive and the other negative.



Advantage was taken of the properties of the Leyden jar by Harris, to construct what he calls the *unit jar*, for measuring out definite quantities of electricity. The unit jar is a small Leyden phial insulated on a rod of glass, with a wire attached to the outer coating, terminating in a knob, *a*, placed at a small distance from a similar knob, *b*, proceeding from the wire which passes into the interior. The bottom of the jar is also furnished with a knob, which may be connected by means of a wire with the prime conductor of the electrical machine, while the foremost knob of the unit jar may be similarly connected with the knob of a Leyden jar, the charge of which is to be measured. On turning the electrical machine, the outer surface of the unit jar becomes positively electrified, and an equal amount of positive electricity passes from the interior of the unit jar into the Leyden jar. As soon as the unit jar is fully charged, a spark passes between the balls, *a*, *b*, and equilibrium is for a moment restored; but as the machine is kept in action, the outer surface of the unit jar becomes again charged, an equivalent quantity of positive electricity passes into the Leyden jar, and the unit jar discharges itself as before. In this way by counting the number of sparks which pass between the knobs, *a* and *b*, a numerical value can be given to the charge of the Leyden jar. The distance between the balls, *a* and *b*, can be adjusted at pleasure; but supposing that distance to remain equal, successive charges in the Leyden jar will also be equal, provided the same number of sparks passing between *a* and *b* be counted for every charge.



By means of an apparatus of this kind and a modification of the common balance, Harris was enabled to measure the force of attraction between two charged surfaces. For one of the pans of the balance, a disc of gilt wood was substituted, beneath which was placed a similar disc insulated. Attached to the metal support of the balance beam was a wire connected with the outer coating of a Leyden jar, and the suspended disc was connected by conducting materials with the balance and the support, while the lower insulated disc was connected by a wire with the inner coating of the Leyden jar. The scale pan on the left contained grain weights, and the support underneath was to prevent the too great oscillations of the balance. On measuring off into the Leyden jar, by means of the unit jar, a quantity of electricity sufficient to produce between the discs an attractive force that would raise 4 grains in the opposite scale pan, it was found that a double charge of electricity would raise 4 times the amount, or 16 grains, while a triple charge would raise 9 times the amount or 36 grains, so that the area of charged surface remaining constant the attractive force increases as the square of the quantity. If a single charge consisting of ten sparks or units be divided between two Leyden jars presenting equal amounts of covered surface, the attractive force will be diminished to one-fourth, and with three jars to one-ninth, as compared with a single jar, so that a charge which in one jar would raise 18 grains would if diffused over two jars raise only 4½ grains, and if diffused over three jars, it would raise only 2 grains. Hence, the quantity of charge remaining the same, the attractive force is inversely as the squares of the charged surfaces of the jars.

When the electric equilibrium has been disturbed there are three modes in which it may be restored, namely, by *conduction*, by *disruption*, and by *convection*. When, for example, a charged jar is discharged by means of a discharging rod, the electricity is conducted quietly through the wire of the discharger so long as contact is maintained, but in traversing the air between the knob of the jar and that of the rod, a brilliant spark passes, accompanied by a crackling noise. After the jar has been discharged, a second smaller spark, known as the *residual charge*, may be obtained from it. Faraday considers this to arise from the circumstance that all bodies, including even resin and glass, have a certain amount of conducting power, by virtue of which a portion of the charge penetrates the substance of the dielectric, the two surfaces being in opposite states. As soon as the principal discharge has been made, and the force which caused this penetration removed, the electricity returns to the surface, re-charges the jar to a small extent, and thus accounts for the residual charge. As no substance insulates perfectly, so no substance conducts perfectly, since there is experimental proof that the resistance to discharge offered by a long thin wire may be greater than that offered by a stratum of air, so that the discharge will take place through the insulating air, rather than along the conducting wire. Indeed the resistance offered by conductors may be considered as insulation: increase the resistance, and the conducting power is diminished and the insulating power proportionally raised; but in general the resistance to conduction is manifested by the evolution of heat, the measure of which is inversely as the conducting power. Harris contrived a kind of air thermometer with a large bulb, across which could be placed wires of equal length and thickness, and he found that on discharging equal quantities of electricity through these wires in succession, he was enabled to assign numerical values to them, the smallest numbers being given to the best conductors, or those which emitted the least heat. Thus copper and silver were each represented by 6, gold by 9, zinc 18, platinum 30, iron 30, tin 36, lead 72. By alloying the metals with each other the conducting power was in some cases greatly reduced: thus, an alloy of 3 parts gold and 1 part copper, gave the conducting power of 25, while gold 1 and copper 3, gave only 15. Gold 3 and silver 1 = 25, tin 1 and lead 1 = 54, tin 1 and copper 3 = 11, and brass = 18. When different quantities of electricity were transmitted through the same wire, it was found that the increase in temperature was as the square of the quantity; so that if the thermometer with a given charge rose 10°, 4 times that charge were required to raise it twice that amount or 20°. Thin wires of silver, steel, platinum, copper, &c., can be readily fused and dispersed by sending a strong charge through them. The amount of such charge as measured by the unit jar is equally powerful, whether diffused over a large or a small surface. The intensity of the charge, as expressed by the quantity of electricity passing through a given space in a given time, is the same in the wire, although the intensity of the charge on equal surfaces of the jar may vary. It must be remembered that although in the charge we have chiefly to deal with surfaces, yet in the discharge, all the particles, (that is, the whole thickness of the conducting wire,) are concerned in the result. In the discharge by disruption, the particles of the di-electric gradually become more and more highly polarised or excited, the tension on one or more particles becomes so great as to exceed the limits of resistance, the opposite induced forces cease to balance each other, and the discharge passes along the line of least resistance, accompanied by light, heat, and noise; while portions of the solid conductors become detached and give characteristic colours to the spark. By this transference of metallic particles from one conductor to another, particles of silver may be precipitated on copper, and even made to penetrate its substance; and there are cases in which gold has been made to penetrate a plate of silver, and appear on the opposite side where the sparks passed. For some grand examples, however, of disruptive discharge we must refer to LIGHTNING.

We have seen that in air of whatever density (unless so rare as to conduct), the same amount of charge produces the same extent of conduction, other things being equal. The distance through which the discharge of equal quantities of electricity, or what is called the *striking distance*, takes places, varies inversely as the pressure. A double pressure doubles the number of aerial particles in the same space, and double the amount of insulating matter is required to be polarised; for example, if in air, at common pressure the striking distance be two inches, at double that pressure it would be one inch; halve the pressure and it would be 4 inches, at one-fourth the pressure 8 inches, and so on until *in vacuo* the striking distance would be unlimited. When the density of the air remains constant, the striking distance varies as the intensity of the charge. Thus, if the striking distance be with a certain charge 1 inch, at double that charge it will be 2 inches, at treble that charge 3 inches. But with equal charges the striking distance varies in different gases, irrespective of their relative density, so that each gas has a specific insulating power; thus hydrochloric acid has twice the insulating power of atmospheric air, and three times that of hydrogen of equal elasticity. When the discharge takes places between a good conductor presenting a small surface, and a bad one of larger surface, there is a rapid but intermitting succession of discharges to the particles of air around; and the sparks thus diluted form a *brush*, which has a quivering kind of motion, and is attended by a subdued roaring noise: its root is brighter than the rays. The phenomena of the brush vary in different gases, the most beautiful effects being produced in nitrogen. The largest brush is produced from a surface charged with vitreous electricity: when a point is held to a surface charged resinously, a *star* or point of light is produced instead of a brush. When the charge is feeble, discharge is sometimes effected by a quiet *glow* instead of the noisy brush, and *convection* then takes place, that is, a current of air conveys the charge to a distance, which current has sufficient force to give motion to electrical toys arranged for that purpose.

The duration of a flash of lightning, or of the spark discharge of a Leyden jar is so instantaneous, that the most rapid motions which we can give to machinery appear to be rest as compared with it. Thus, if we print the words AT REST in large letters on a disk of cardboard, and cause this to spin rapidly round upon an axis through its centre, the words will of course disappear; but if we allow the flash of a Leyden jar to illuminate the disk, the words may be read with perfect ease, since the light has come and gone before the disk had time to move through any appreciable space. In this way Wheatstone has shown that the light of the electric discharge lasts less than the millionth of a second. Suppose a small wheel of dull metal to contain 100 bright equidistant rays, and to revolve 10 times per second, or once in the $\frac{1}{10}$th of a second. The appearance of these radii, as seen by the reflected light of an electric spark, will differ according to its duration. If the time be infinitely short, the reflexion during $\frac{1}{10}$th of a second will give the appearance of 100 fixed luminous rays. If it last $\frac{1}{1000}$th of a second, the whole circle will be luminous, since the impression of each ray upon the eye will remain until that of the succeeding ray is produced. For a duration of $\frac{1}{2}$, $\frac{1}{3}$rd, $\frac{1}{4}$th, $\frac{1}{8}$th, &c., of $\frac{1}{1000}$th of a second, corresponding illuminated segments will be seen, and $\frac{1}{2}$nd, $\frac{2}{3}$ds, $\frac{3}{4}$ths, or $\frac{7}{8}$ths of the circle will appear deprived of light, that is, there will be alternate bright and dark spaces corresponding to those quantities. By increasing the size of the wheel, the scale of these measures may be augmented, as may also its subdivision by increasing the velocity, or by multiplying the number of the spokes. By a modification of this apparatus, called the *Chronoscope*, Wheatstone was able to measure the velocity of the discharge of a Leyden jar through an insulated copper wire, and he estimated it 288,000 miles per second. ('Phil. Trans.,' 1834.) The copper wire was about half a mile in length, and was broken at three points, one within a few feet of the inner coating of a Leyden jar, a second in the middle of the wire, and a third near the outer coating of the jar, and the wire was so contorted that these three breaks were arranged side by side on an insulated disk or *spark board*, so that the three sparks could be seen simultaneously. When the jar was discharged through this half mile of wire the three sparks appeared to be simultaneous, but when seen by reflexion in a small steel mirror rapidly revolving on an axis parallel to its surface the sparks did not appear as points of light in the same horizontal line, but gave the appearance of three bright lines of equal length; the two outer lines were found to begin and end within the same horizontal space, but the middle one coming a little later than the others, the angular position of the mirror advanced somewhat before the middle spark made its appearance. Now, as the velocity of the mirror was known, and the amount of angular deviation of the central spark could be easily ascertained, the retardation of the discharge by the copper wire, or the velocity with which it moves through it, can be estimated. Professor Miller, who in his 'Elements of Chemistry,' part 1, gives a succinct but masterly sketch of modern electrical science, remarks that this experiment "affords a convincing proof of simultaneous action and reaction in the operations of electricity, and of its existence as a duplicate force: at the same moment that a positive influence leaves the inner coating, an equal amount of negative influence leaves the outer coating, and these two neutralise each other at the central point of the conductor, after the lapse of an extremely minute but still appreciable interval of time. It appears from this experiment that Franklin's theory, though in many cases a simple and convenient mode of explaining facts, is not the true representation of the phenomena. The theory of two fluids, or rather of two forces, acting in opposite directions, seems by this experiment to be demonstrated." It must be remarked, however, that the velocity of the electric discharge varies with the intensity of the charge and the nature of the conducting medium.

ELECTRICITY, ATMOSPHERIC. The similarity of lightning to the spark obtained by friction from an electrical apparatus was observed by the earliest experimenters in electricity; and in one of Franklin's letters, written apparently before the year 1750, the points of resemblance are distinctly stated. The first fruit of this discovery was the employment of thunder-rods for the protection of buildings and ships; and rods or wires projecting above the tops of edifices were soon extensively used by philosophers for the purpose of enabling them to ascertain the nature and intensity of the electricity in the atmosphere. Such means are not unattended by danger; and science has to record the death of Professor Richman, during a thunder-storm, while attending to the indications of the electrometer connected with an apparatus of that kind. [LIGHTNING.]

Franklin in America, M. de Romas in France, and Cavallo in England, each employed, for the purpose of bringing electricity from the atmosphere to the surface of the earth, a kite made of silk stretched on a frame, from the upper part of which projected a piece of pointed metal, and from which proceeded along the string a slender metallic wire. M. Buffon, M. Lemonnier, and others, planted vertically in the ground poles, from 30 to 40 feet in height, carrying at the top a pointed piece of tin or iron, from which descended a metallic wire. M. Mézèas in France, Mr. Ronayne in Ireland, and Mr. Crosse in England, employed long wires in horizontal positions, which were insulated by being stretched between two glass pillars, each on the top of a pole planted in the ground. The wire used by Mr. Crosse was 1800 feet long, and was above 100 feet from the ground. MM. Becquerel and Breschet examined the electric state of the air in the upper regions by means of a cord covered with tinsel about 90 yards long, one end of which was placed on the cap of a gold leaf electroscope, and the other was attached to a metal arrow which was shot into the air. The gold leaves were seen to diverge in proportion to the ascent of the arrow. (Becquerel, 'Traité de l'Electricité,' t. iv.)

The numerous experiments made by Cavallo serve to prove that the electric fluid always exists in the atmosphere, but in very different quantities at different times, and that it is more abundant in the higher regions than near the earth. The same philosopher found, also, that it is more intense in frosty than in warm weather, and that fogs are accompanied by a great quantity of electricity, except when they become rain; in this case little electricity is perceptible, the rain conducting to the earth the electricity of the air above. In high winds, also, the intensity of the atmospherical electricity is generally diminished, probably because the strata of air containing different quantities of the fluid are brought successively to the ground, and thus there is produced a nearly uniform distribution of the fluid between the earth and the atmosphere. It may be easily conceived that, in stormy weather, the variations of the atmospherical electricity will be very irregular; for currents of air in the upper regions, driving the strata of clouds in different directions, the electrical actions between the clouds and the atmosphere below must be extremely complex.

M. de Saussure has observed that, during summer and winter, by night as well as by day, when the atmosphere is free from clouds, the electricity of the air is positive; and Mr. Read ('Phil. Trans.,' 1794) has shown that out of 404 observations made in one year, the air was positively electrical in 241, negatively in 156, and that the electricity was insensible in 7 observations only. It seems probable, in fact, that the negative electricity which may be observed in a pure atmosphere is caused by the discharge of its positive electricity into the earth or a cloud, when one or the other of these is in a contrary state. Mr. Ronayne, however, states ('Phil. Trans.,' 1772) that in Ireland the electricity of the atmosphere is positive in winter when the air is clear: he observes that it diminishes in frosty or foggy weather, and that he could detect no electricity in the air during the summer except when a fog came on; the electricity was then positive, but it was less intense than during the winter fogs. It was an observation of Saussure that electricity is strongest in the open air, and that it is weak in streets, in houses, and under trees. In close rooms and hospitals the electricity of the air has been always found to be negative; such also is the electricity of the atmosphere when it is vitiated by exhalations from lime, paint, and decaying vegetables. [OZONE.]

All observations concur in showing diurnal variations in the intensity of atmospherical electricity, but there is some uncertainty concerning the precise times at which the intensities are the greatest and the least. Cavallo observed that in dry weather the electricity was weakest at sunrise; that it attained the maximum of strength in the day-time, and continued in that state till sunset, when the intensity diminished. He conceived that this diminution was much more rapid as the air became more humid; and he observed that in winter, when a dry wind prevailed, if the sky were free from clouds, the electricity became very strong after sunset. M. de Saussure observed at Geneva (1785) that, during winter, the intensity of atmospherical electricity attained its first maximum at 9 A.M.; that it diminished till 6 P.M., when it was in a minimum state; it afterwards increased, and attained its second maximum at 8 P.M.; after which it continued to diminish till it was again a minimum at 6 on the following morning. The same philosopher found that in summer the diurnal variations were less perceptible: on a dry warm day he found the electricity increase from sunrise, when it was almost insensible, till 3 or 4 P.M., when it became a maximum; it appeared then to diminish till the dew fell, when it became stronger, but it was scarely sensible during the night. Lastly, the experiments of Mr. Read exhibit two maxima and two minima in twenty-four hours. The atmospherical electricity seemed strongest at two or three hours after sunrise, and again about sunset; it was weakest at noon and at 4 P.M.

The experiments of Mr. Crosse show also that, in the ordinary state of the atmosphere, the electricity is positive, and that it increases in proportion to the elevation above the earth's surface; the same philosopher observes that it is most intense at sunrise and sunset, and weakest at noon and during the night. He finds that the approach of a thundercloud produces a change in the electricity of the atmosphere, rendering it positive if it were before negative; and the contrary: whatever be the nature of the change which takes place, the intensity of the electricity increases to a certain degree; it then diminishes and disappears, and is succeeded by an opposite electricity: this gradually increases till it becomes of higher intensity than the former kind, and then it decreases till it vanishes: it is again succeeded by the first kind. These changes are often found to take place several times successively. Fogs, rain, snow, &c., also change the electricity from positive to negative, again from negative to positive, and so on; the change taking place every three or four minutes. A cold rain, in large drops, is frequently accompanied by intense electricity; and during a driving fog or rain the electricity is occasionally as strong as during a thunder-storm. A warm small rain is weakly electrified; and a weak positive electricity generally prevails during cloudy weather. Mr. Crosse finds also that the electricity of the air is very weak during the north-east winds which in winter and spring times produce extreme cold and dryness.

The intensity of atmospherical electricity has been observed to undergo annual changes; it increases from July to November inclusive; so that the greatest intensity occurs in winter, and the least in summer.

Any of the different kinds of electrometer may be employed to determine the nature and intensity of atmospherical electricity. [ELECTROMETER.] Professor Loomis states (Poggendorff's Annalen, Band 100), that the telegraphic wires are very sensitive to an approaching thunder-storm, and often become highly charged even when a storm is so distant that neither thunder nor lightning can be appreciated; but if the thunder-cloud be near, the wires may become so highly charged as to injure the magnetic apparatus and expose the clerks to considerable danger. Such effects, however, are not peculiar to America.

Later observations have confirmed the conclusion that the usual electrical condition of the air is positive. Out of 15,170 observations made at the Kew Observatory, during a period of 5 years, 14,515 are of positive electricity, and 655 of negative. During the years 1845, 1846, and 1847, out of 10,500 observations, 10,176 showed positive, and only 324 negative electricity; the latter being usually accompanied by heavy rain. The tension of atmospheric electricity was found to be at its minimum at 2 a.m., from which hour there was a gradual increase until 6 a.m.; after which the tension increased more rapidly, its value at 8 a.m. being nearly double that at 6 a.m.: the increase then became more gradual until 10 a.m., the period of the first or morning maximum: from this hour it gradually declined until 4 p.m., when it was only a little higher than at 8 a.m.; it then increased rapidly until 8 p.m., and after a slight rise at 10 p.m., the time of the principal or evening maximum, the tension was found no longer to increase. The evening maximum was much higher than that of the morning. Between 10 p.m. and midnight the tension decreased nearly to that of the diurnal minimum. With regard to the annual period the lowest tensions were found to be in June and August, the tension during July being slightly superior to that of those two months. There is a slight elevation in September, which increases in October, and more rapidly from November to January. The maximum is in February. In March a rapid diminution sets in, and proceeds to the minimum in June.

During four years' observations made at Brussels by M. Quetelet, the maximum was found to be in January, and the minimum in June. Expressed numerically the maximum had the value of 605°, and the minimum 47°; so that the electricity in January is thirteen times more energetic than in June. The difference was found to be much more sensible during serene than cloudy weather, and, setting out from June, the electricity of the air in serene weather was found to exceed the electricity observed during a clouded sky, in proportion as January was approached, in which month the ratio was more than 4 to 1. The powerful electric intensity of the air during a serene sky in winter must be considered as a remarkable fact. A high electric intensity was always observed during fog and snow.

Atmospheric electricity seems to depend for its supply chiefly on evaporation. It can be proved by experiment that the evaporation of water from heated bodies disturbs the electrical equilibrium, the + electricity being carried off by the vapour, while the − electricity is left behind in the vessel, or is carried off by its support. In order to produce this result, however, some chemical change seems to be necessary, since the evaporation of pure water fails to produce electrical disturbance. When water is evaporated from alkaline solutions the vapour carries off − and leaves + electricity behind; but the reverse of this takes place when water is evaporated from an acid or from neutral saline solutions, including sea-salt. During the processes of vegetation, in which water is largely separated from the other constituents of plants, there is also electrical disturbance. Volcanic eruptions and conflagrations are also accompanied by strong electrical excitement. The friction of wind, dust, &c., is also a source of atmospheric electricity. Dr. Livingstone ('Missionary Travels, &c., in South Africa,' 1857) states that in the Kalahari Desert, during the dry season, a hot wind occasionally blows, and it is "in such an electric state that a bunch of ostrich feathers held a few seconds against it, becomes as highly charged as if attached to a powerful electrical machine, and clasps the advancing hand with a sharp crackling sound." Even the motion of a native in his kaross is sufficient to produce therein a stream of small sparks.

There are many difficulties in accounting for the presence of free electricity in the air. Perhaps the best theory is that started by Eales ('Phil. Trans.' 1757-8), and extended by Sir John Herschel ('Encyc. Brit.,' 8th ed., Art. Meteorology). We will state sufficient to indicate the nature of the theory. When water evaporates it is supposed to pass off in the form of little vesicles of moisture, each vesicle charged with electricity of too low a tension to discharge itself into neighbouring vesicles, or to escape by conduction through a moist atmosphere. If, however, a tall pointed conductor, a flame, or a column of smoke, be introduced, the air may give off a portion of electricity by contact discharge. But if we suppose a number of the particles of vapour thus electrified to be condensed by cold into a drop of water, the whole of the electricity would be collected on the surface of such drop with a corresponding increase in tension. Suppose one such drop to be 1000 times the size of one of its constituent particles, the diameter will be increased 10 times and the surface 100 times, while the electricity being the sum of the 1000 globules will be increased 1000 times on the surface of the drop with a tenfold density or tension. The comparatively high electric state of fog, and of snow, is thus explained. Every globule of moisture of which it consists has a coating of electricity, which it will part with to the surface of any conductor, and the denser the fog, and the larger its globules, the greater is the quantity of electricity set free. This theory also explains the electricity of the air as occasioned by the deposit of dew, and also the daily variation in tension; for the air losing a great deal of vapour by a deposit of dew, by night the electricity is at its minimum. It increases as fresh vapour arises under the influence of the ascending sun; decreases as the growing warmth of the air enables it to hold a still larger amount of vapour uncondensed, and as the vapour itself rises rapidly to form cloud; increases again towards the evening, when dew begins to form at sunset and vapour to settle into globules, and once more decreases as the number of these electrified globules diminishes by deposition and diffusion. A large portion of the electricity near the surface is returned to the earth by slow conduction, and the more so in proportion as the air is moist. The great and sudden increase of electrical tension, sufficient to produce a flash of lightning, and a torrent of rain, will be noticed under LIGHTNING; RAIN.

The aurora borealis, and some other meteoric appearances, have been ascribed to the electricity of the atmosphere. [POLAR LIGHTS.]

ELECTRICITY, ANIMAL. [ELECTRICITY OF ORGANIC BEINGS, NAT. HIST. DIV.]

ELECTRICITY, *Medical application of.* A supposed analogy between electricity and the nervous power has led to the employment of this agent, particularly in diseases connected with defective nervous energy, and also in cases of defective secretion, perhaps originating in a similar cause. The influence of electricity on the human system differs much according to the manner in which it is applied, the length of time during which it is continued, and the degree of intensity. It also differs in its action according as it is abstracted from, or communicated to, the individual. When applied in a moderate degree of intensity, it occasions an increase of nervous action, of sensibility and irritability, more vigorous circulation of the blood, augmented warmth, and secretion, especially cutaneous transpiration: even the exhalation of plants is much increased by electricity. When the electric principle is more intense, all these actions are heightened, often to a painful degree; while such a degree of concentration as occurs during certain atmospheric changes can occasion instant death. Death occasioned by this means is always followed by rapid decomposition of the body. The diseased states in which electricity has been found most useful are—in asphyxia, from any cause (except organic disease of the heart), but particularly from exposure to irrespirable gases; in certain asthmatic diseases; and dyspepsia, dependent on irregular or defective supply of nervous energy to the lungs and stomach. It is, however, much inferior to galvanism as a remedial agent in these diseases. (Wilson Philip 'On the Vital Functions.') In local paralytic affections, when of a chronic character, electricity, duly persevered with, has been found very useful: in a case of dysphagia, from paralysis of the œsophagus, the patient could only swallow when placed on a seat resting on non-conductors and electrified. In deafness and loss of sight, when directed by a competent judge, it has restored the functions of seeing and hearing. Lastly, in defective secretion, especially amenorrhœa, it has proved of service. Recently, M. Becquerel and others have employed electricity, with complete success in six cases, where the milk has been suppressed, as an exciter of the mammary secretion.

ELECTRO-CHEMISTRY. Electricity, like heat and light, both affects and is affected by chemical change: and just as heat more often appears as a cause or consequence of chemical change than does light,—so galvanic, or low-tension (voltaic) electricity is more prominently concerned as cause or effect in chemical change, than is the so-called frictional or high-tension electricity. Hence, in electro-chemistry, the relation of chemical change to galvanic electricity has almost exclusively to be considered.

The order will be adopted of considering (1) the chemical changes effected by a galvanic current; (2) the galvanic current produced by chemical changes.

If the two poles of a battery be brought into contact with two points of a homogeneous substance, the substance may either conduct the current without suffering chemical change, it may refuse to conduct the current at all, or finally it may conduct the current and suffer chemical change.

No instance is known in which a true chemical compound conducts a current without suffering chemical alteration; but substances which are simple, as far as evidence goes, may refuse to conduct a current. Moreover no chemical compound substance conducts unless in a state of liquefaction, such liquefaction being caused either by solution in media or by igneous fusion.

As a class, the metals are the best conductors of electricity. With regard to the resistance offered to a galvanic current by various conductors, some of which are unaltered, some decomposed by it, we may compare the numbers of the following table (Buff, Zamminer, and Kopp's 'Lehrbuch'), in which the resistance to the same galvanic current offered by the same lengths and thicknesses of some conducting substances is given, the resistance offered by silver being taken as unity:—

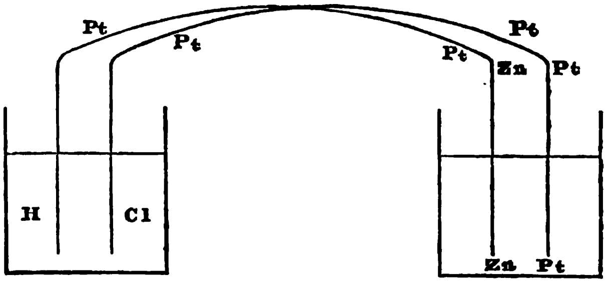
Silver	1·000
Copper (chemically pure)	1·043
Copper (commercial)	1·270
Brass (composition not stated)	5·372
Iron	8·427
Platinum	9·590
German silver (composition not stated) . .	12·400
Mercury	29·238
Sulphuric acid (sp. gr. 1·2 to 1·36) . . .	761732·000
Sulphate of zinc (33·58 *per cent.* of anhydrous salt in solution . . , ...	11019012·000
Sulphate of copper (20·83 *per cent.* of anhydrous salt in solution)	14809320·000

From what has been said, it follows that the latter three of these substances are decomposed during the passage of the current through them. The presence of more than one element in brass and German silver is not in contradiction to the general rule laid down; for the metals present in these alloys are not in chemical union, and the alloy conducts the current in the same manner as would a bundle of wires consisting in part of one metal, in part of the other. The conducting power of the metallic conductors is diminished by an increase of temperature, that of the compound solutions is always increased.

In examining the nature of the changes wrought in compound conductors when submitted to, and therefore decomposed by, the electric current, it will be convenient to suppose, in the first place, that the poles by which the current is led through the substance are themselves chemically inactive, that is, of such a nature as not to be acted on by any of the products of decomposition. In practice, when this passivity is desired, the poles are usually made of platinum, and this will in the sequel be always tacitly assumed to be the case, unless the contrary be expressed.

The decomposition of a compound substance by galvanic electricity is called the *electrolysis* of that substance. The body so decomposed is called an *electrolyte.* The two poles between which the current passes through the electrolyte are the *electrodes.* The positive (+) electrode, or *anode*, is the one in metallic connexion with the inactive element of the battery (Platinum, Carbon). The negative (—) electrode, or *cathode*, is in connexion with the active or attacked element of the acting battery (Zinc). The products of electrolysis of the electrolyte are sometimes called *ions.* That *ion* which appears at the negative electrode or cathode is the *cation;* that at the positive electrode or anode is called the *anion.* (According to strict analogy, this latter nomenclature should be inverted.)

Thus, if the two platinum poles of a battery be inserted into a solution of chloride of hydrogen (hydrochloric acid), chlorine is liberated at the positive electrode or pole, and hydrogen at the negative one: in the manner of the skeleton diagram:—



If water be substituted for hydrochloric acid, oxygen appears at the positive pole, hydrogen at the negative one. If solutions of other chlorides be used, such as chloride of copper, of gold, &c., the metal is precipitated at the same pole (the negative) at which the hydrogen was evolved, the chlorine at the positive one. In accordance with that terminology built upon the indistinct notion that unlike things seek to approach, and that, conversely, things which seek one another do so by virtue of dissimilarity or oppositeness of their conditions, those ions which appear at the negative pole are called electro-positive, those which are set free at the positive pole are called electro-negative. Thus, in the instances given:—

+	—		
H	O	. . .	Water.
H	Cl	. . .	Chloride of hydrogen.
Cu	Cl	. . .	Chloride of copper.
Au	Cl	. . .	Chloride of gold.

the elements in the first column are electro-positive, those in the second electro-negative.

If now, instead of binary compounds of this kind we submit aqueous solutions of oxygen acids, or salts of such, to electrolysis, we find that in the first instance, that is, in the case of the free acids (or hydrogen salts) hydrogen is liberated at the negative pole and oxygen at the positive one. If a metallic salt of such an acid be electrolysed, the metal is deposited at the pole where hydrogen is liberated, while oxygen, as before, escapes at the positive pole. It is by laying weight upon the analogy of decomposition, in the cases of binary salts and oxygen ones, that the similarity of their constitution has been supported. For, if we imagine the electric current to enter the electrolyte by the positive pole (anode), and to withdraw all the negative atoms (chlorine) of the molecules of hydrochloric acid in contact with it; as the hydrogen so freed does not escape *in loco,* it is easy to imagine the atoms of hydrogen to decompose the molecules of hydrochloric acid in their neighbourhood, liberating hydrogen again, and that these decompose fresh molecules of hydrochloric acid, liberating hydrogen, and so on. So that, wherever the cathode may be, that is, wherever the negative pole is situated and such successive decomposition has to cease, in consequence of the current finding a metallic conductor (the cathode) by which it may leave the electrolyte, it is clear that there hydrogen will be evolved. As the results of the electrolysis of sulphuric acid and the sulphates are analogous with those of hydrochloric acid and the chlorides, namely the appearance of hydrogen or metal at the negative pole, and oxygen or chlorine at the positive one, it is not difficult to suppose the two to be similarly constituted; and that sulphates, nitrates, &c., are made up, like the chlorides, of two parts, one electro-positive the other electro-negative :—

+	—	+	—
H	Cl	H	SO_4
Cu	Cl	Cu	SO_4
		Cu	NO_6

This hypothesis of the constitution of oxygen salts is supported by the law of equivalent electrolysis, which we shall discuss directly. It requires, however, the assumption of hypothetical substances, SO_4, NO_6, &c., which are not separated as such, like chlorine, but must be decomposed, as soon as formed, into oxygen, which appears, and the anhydrous acid, SO_3, NO_5, &c., which finds water with which to combine. It is these hypothetical molecules, SO_4, NO_6, &c., which must be supposed to be successively liberated by the liberated atoms of hydrogen or metal from the molecules of the salt, in the same manner as is the case with the halogens in binary compounds. However, the necessity for this hypothesis cannot be considered as very hostile to the haloidal constitution of oxygen salts, for many instances are known where the actual ultimate products of electrolysis (or ions) appear, by the strongest possible analogies, to be products due to the chemical action between the initial ions and the unaltered electrolyte in contact with them. Thus, if instead of chloride of copper, chloride of sodium be submitted to electrolysis, chlorine as before is evolved at the positive pole, while at the negative not sodium but hydrogen is evolved. Now Cu Cl and Na Cl are certainly chemically similar. Further, if the anhydrous salt be employed in the fused state, sodium is actually liberated: finally, if sodium were set free in an aqueous solution at the negative pole, the products would be the same as they are actually found to be, for water would be decomposed, soda formed, and hydrogen evolved. Again, by altering the nature of the positive electrode, we may affect the nature of the ion appearing there. Thus, if the electrolyte be dilute sulphuric acid, and the positive electrode be of zinc amalgam, the oxygen which, had the positive electrode been platinum, would have been liberated there, combines with the zinc and dissolves as sulphate of zinc in the sulphuric acid. Or, further, even by altering the strength of the electrolyte (sulphuric acid), the products may be affected; for unless the acid be dilute, a part of the oxygen, instead of escaping as such, combines with the water to form HO_2, which dissolves in the electrolyte. It is, indeed, on the power we have of altering the nature of the ions, that the construction of constant batteries depends. In Daniell's for instance, the hydrogen, which would collect at the negative pole (which is of copper) and check the current by interposing a partial cushion of a non-conducting gas, is made, by placing a solution of sulphate of copper round this pole, to precipitate an equivalent (chemical and electrical) of metallic copper, itself being converted into water and combining as such with the sulphuric acid of the sulphate of copper; whereby the electrode continues to be coated with fresh portions of metallic copper. In Grove's and Bunsen's batteries, again, the hydrogen which would be liberated at the negative pole is there instantly oxidised to water by the nitric acid which surrounds it.

In organic compounds, where the electrolyte is often of a very complex nature, it is frequently difficult or impossible to recognise the primitive ion, and to distinguish it from the products of its action upon the electrolyte in contact with it.

It is in considering the products of electrolysis, or ions of an electrolyte, that the atomic theory receives prominent illustration; or, conversely, it [illegible]om the atomic hypothesis that the clearest light is thrown upon the process of electrolysis.

Suppose the current from a battery to pass by one electrode into a vessel of water: let the other pole be immersed in a vessel of chloride of copper, and let an arc of platinum be placed with one limb in each vessel. The current from the battery will enter the water by the positive electrode P_1, will traverse the water and escape by the negative electrode N_1; passing along the arc, it will enter the solution of copper by the positive electrode P_2, traverse it, and escape by the negative electrode N_2: thus regaining the battery after having traversed both vessels. Now from what has been said before, it is self evident that for every atom or equivalent of oxygen liberated at P_1 there must be an equivalent of hydrogen liberated at N_1, that is, if the whole of each ion set free escapes. Further, that for every atom or equivalent of chlorine liberated at P_2, there must be an atom or equivalent of copper deposited at N_2 (under the same restriction). In other words, the hydrogen and oxygen will be in the proportion of 1 to 8, and the copper and oxygen in that of 1 to 0·25. So much is in accordance with the purely chemical law. But it is further found that the quantity of hydrogen in the first vessel is to that of copper in the second as 1 to 32, and therefore to that of chlorine as 1 to 35·5, so that the quantities of all four ions are in the proportion of their equivalents. The same is true, however many electrolytes a current has to decompose in its course, and this constitutes the great law of *equivalent electrolysis.* It is easy to understand that the same law is essentially true when the primitive products of decomposition undergo further change in presence of the electrolytes. Thus, if a current traverses two neutral solutions, the one of sulphate of potash the other of phosphate of soda, each of which is divided into two portions by a porous diaphragm in such manner that the sulphuric and phosphoric acids, freed at the positive electrodes, shall not mix with the potash and soda at the respective negative poles; then, however long the current has passed through, not only will the liberated phosphoric acid exactly neutralise the liberated soda of the same cell, it will also neutralise the caustic potash of the other one; and the same is true *mutatis mutandis* of the sulphuric acid. For the metals potassium and sodium, initially separated, being equivalent, will by their oxidation give rise to equivalent quantities of potash and soda. The meaning then of the law of equivalent electrolysis is, that the power which a current possesses of effecting chemical change is exerted throughout its course in equal degrees wherever such chemical change is effected.

It follows that by ascertaining the whole amount of one ion liberated at any electrode of a current which passes through any number of electrolytes, we ascertain the quantity of every other ion liberated by the same current (or, of its equivalent derived by secondary change). A practical application of this is exemplified in the construction and use of the voltaic electrometer or voltameter. This instrument is, in fact, nothing more than a cell containing acidulated water, which is introduced into the current and decomposed by its means between two platinum electrodes. By a simple arrangement, the amount of hydrogen liberated at the negative electrode is collected and measured. Or the oxygen and hydrogen from the positive and negative poles are collected together. In the latter case, of course, for every 9 parts by weight of the mixed gases, every other ion freed in the circuit has been liberated in quantity proportional to its equivalent. The hydrogen liberated at the negative, and the oxygen liberated at the positive pole exhibit all the powerfully developed affinities of these elements in the nascent state. Thus many oxygenated or chlorinated organic bodies which refuse to part with their oxygen or chlorine under ordinary conditions, and which may refuse to conduct the current when pure, will give up their electro-negative elements to the hydrogen at the negative pole of a galvanic current when, by mixture with an acid and aqueous solution, they are made to conduct, and hydrogen is furnished. Under the same conditions many substances may be oxidised by the oxygen liberated at the positive pole. Thus by mixing chloroform with alcohol and dilute sulphuric acid, and submitting the mixture to electrolysis, the hydrogen at the negative pole replaces the chlorine of the chloroform, and hydride of methyl, or marsh gas is formed. Again, if a solution of caustic potash be submitted to the action of a current, the positive electrode of which is metallic iron,—the iron becomes peroxidised to ferric acid, and ferrate of iron is formed at this pole. So, a solution of cyanide of potassium gives when similarly treated, cyanate of potash at the positive pole. The same powerful affinity is exhibited by other electro-negative ions; thus, for instance, when chloride of ammonium in solution is electrolysed, chloride of nitrogen is formed at the positive pole. It will, however, be borne in mind, that a part of the oxidising action of electrolytic oxygen may be due to the formation of binoxide of hydrogen, as before mentioned, or perhaps, to that of a still higher oxide (ozone). That the electrode itself may undergo change by the action of the ion liberated upon it, has already been exemplified. An instructive instance is furnished by the electrolysis of fused chloride of silver, when the electrodes are of silver. In this case silver is deposited in crystals upon the negative electrode, while the chlorine at the positive one combines with the silver of which that electrode is formed. Thus the amount of chlorine in the electrolyte remains unchanged, but fresh portions of silver are continually being transferred through it, from the positive to the negative electrode.

If a current be led through a solution of various metallic salts, the metal precipitated at the negative pole is not an alloy of all the metals present. Some metals are precipitated in preference to others, and the whole quantity of one metal present is precipitated before the second commences to be thrown down. Thus, from a solution of copper and iron salts, the copper is precipitated before the iron, from a mixture of iron and zinc salts the iron is precipitated before the zinc; finally, from a mixture of copper, iron, and zinc, the copper is precipitated first, then the iron, and lastly the zinc. Zinc is thus said to be more electro-positive than iron, iron more electro-positive than copper, &c. Compared with regard to their electro-positive characters the metals are related to one another as follows :—

Potassium,
Sodium,
Manganese,
Zinc,
Cadmium,
Iron,
Nickel,
Cobalt,
Lead,
Tin,
Copper,
Silver,
Mercury,
Palladium,
Platinum,
Rhodium,
Iridium,
Gold.

The first being the most positive, the last the most negative.

It is by the use of compounds free from water, and rendered conductors by fusion, that the most easily oxidisable metals are reduced from combination by means of the electric current. Thus, fused caustic soda yields oxygen at the positive pole, and metallic sodium at the negative one. The chlorides of aluminium, magnesium, barium, calcium, etc., yield up their metal at the negative pole. In such electrolysis, special precautions must be taken to prevent the metal from becoming re-oxidised, for the details of reduction by such means, see ALUMINIUM, CALCIUM, MAGNESIUM, &c. It may be here mentioned, that for this purpose it is usual to employ mixed chlorides, the melting points of such mixtures being lower than those of the simple chlorides, and the purity of the reduced metal not being impaired by the presence of other metals in the electrolyte, because the more electro-positive is separated in preference to the less electro-positive.

An example of the importance of the light which may be thrown upon the constitution of a compound substance by the electrolytic separation of its parts into the most electro-positive and electro-negative of its constituents, is furnished by the behaviour of the salts of the fatty acids towards the electric current. If valerianate of potash, whose empirical formula is $KO\,C_{10}H_9O_3$, be electrolysed by means of platinum electrodes separated by a porous diaphragm, potassium (that is, potash and hydrogen), appear at the negative pole, while carbonic acid and butyl appear at the positive.

$$\underbrace{KOC_{10}H_9O_3}_{\text{Valerianate of potash.}} + nHO = H + KO + \underbrace{C_8H_9}_{\text{Butyl.}} + 2CO_2 + (n-1)\,HO$$

Whence the formula expressing the electro-chemical constitution of valerianic acid is derived.

$$H,\ C_8H_9,\ 2CO_2.$$

If a piece of zinc be immersed in a solution of dilute sulphuric acid, so that a part of it is above the liquid, an inactive metal, such as platinum (that is, one which is not attacked by the acid), which connects the part of the zinc attacked with the part above the liquid, is found to be traversed by an electric current. This is the type of the formation of all electrical currents by chemical change. And if we assume arbitrarily that the current passes only in one direction,—namely, from the part of the zinc attacked to the part unattacked,—then the direction of the current in this example gives us the direction of the current in all other cases where metals are attacked by acids. Hence when, in the same acid, two metals are placed, of which the one is attacked, the other unattacked, by the acid, a current passes through the liquid from the attacked to the unattacked metal, if metallic contact be established between them above the liquid. But if such metallic connector be broken, and the ends plunged into a liquid containing an electrolyte (*fig.* 1), then such an arrangement of active and passive metal constitutes a battery. The most simple method of interpreting such an arrangement with regard to the "signs" of its parts electrically considered, is by remembering that the part of the zinc immersed is positive; the part out of the acid, together with the connecting wire and attacked electrode, is negative; the opposite electrode, where the chlorous element is eliminated, together with the whole of its platinum connection, as far as the surface of the liquid in the battery, is positive. The part immersed in the liquid of the battery is negative. This comes to the same thing as saying that the positive ion is liberated at the electrode in connection with the positive element of the battery, the negative ion at that connected with the negative element. It must be borne in mind, that the ions appearing at the two electrodes are not *absolutely* positive and negative towards one another. All that is known is that they are in the same relation with regard to sign, as are the elements of the battery by whose action they are separated; and that thus, with regard to sign, all we know on decomposing chloride of silver by means of a Grove's battery is that

$$Ag : Cl :: Zn : Pt.$$

That electric currents are established between the active and passive points of a metal, and that the positive current passes from the active to the passive part, is seen in the example of so-called passive iron. If clean iron be dipped into strong nitric acid, no evolution of gas occurs, and the iron is not acted on. If another piece of iron be first plunged into dilute nitric acid, and then into the strong nitric acid, the decomposition set up in the dilute acid is carried on in the strong acid. It is possible thus in one and the same acid to have two pieces of the same metal, the one of which is active and the other passive. On connecting the two, a current passes through the connector, just as if platinum had been employed instead of the passive iron. Nickel may by the same means be brought into the passive state, and a battery formed of elements of active and passive nickel. It is beyond the scope of this article to describe the conditions under which the passivity of iron is destroyed or preserved.

The power possessed by high tension or frictional electricity of effecting chemical change is very small in comparison with that of low tension or galvanic electricity; and in many cases where chemical change accompanies frictional electricity, it may be traced to the accompanying forces of light and heat.

If an electric spark be made to pass through an atmosphere of mixed oxygen, nitrogen, and water, the nitrogen combines with the oxygen in part and in part with the hydrogen, the two products so formed combining together.

If a spark be made to pass through water by means of exceedingly fine platinum points, minute bubbles of hydrogen and oxygen collect at the poles.

Mixtures of oxygen and hydrogen, or hydrogen and chlorine, are exploded on passing a spark through them.

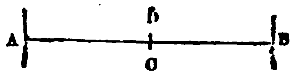
The following are examples of the formation of high tension electricity by chemical change:—

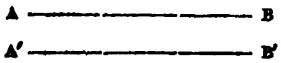
The insulated grate of a stove in which coal is burning is found to be negatively electrical. If hydrogen passes through a metal tube, and is then burned, the tube is found to be negatively electrical. If dry air and chlorine be passed through a thin copper tube, the latter becomes negatively electrical; if the product be then passed through a platinum tube, the latter becomes positively electrical.

With regard to the relative powers of low and high tension electricity to effect chemical change, it has been found that—"A wire of platinum and a wire of zinc, each $\frac{1}{16}$th of an inch in diameter, placed $\frac{5}{16}$ths of an inch apart, and immersed to a depth of $\frac{5}{8}$ths of an inch in an acid consisting of one drop of oil of vitriol in four ounces of distilled water, at a temperature of 60° Fahr., and connected at their other extremities by a copper wire 18 feet long and $\frac{1}{18}$th of an inch thick, yield as much electricity in about three seconds of time as a Leyden battery exposing a surface of 3500 square inches, charged by 30 turns of a plate-glass machine 50 inches in diameter in full action."

ELECTRODE. [ELECTRO-CHEMISTRY.]

ELECTRO-DYNAMICS. In ordinary electricity, that fluid when developed takes a position of equilibrium, dependent on the conducting power of the medium on which it is disposed, on the non-conducting power of the medium by which it is enveloped, and on the law of force, whether of attraction or repulsion, between the elementary portions of electricity. The motions of electrised bodies are only results of the statical equilibrium of this fluid, and do not therefore belong to electro-dynamics. The mode of calculating such effects may be found under the head ELECTRICITY, COMMON. These effects are, moreover, of the same nature, whether the source of electricity be by means of friction, or by chemical action, as in the voltaic pile, the nature of the electricities in these cases differing from each other only in the mode of their production [ELECTRICITY]; but when the contrary electricities are no sooner produced than re-combined, again re-produced, and again re-combined, a new class of phenomena arises belonging to electricity as it were in motion. Suppose, for example, that the plate A is a constant source of positive electricity, the plate B in like manner a constant source of negative electricity of equal intensity; that A C, B C, are two conducting rods communicating with each; the electricities immediately combine when the conductors are made to touch at C, and for an instant the whole may be conceived to be in the neutral state, but A being the next instant replenished with positive and B with negative electricity, the same combination takes place over again, the same neutrality succeeds, and so on indefinitely. The rod A C B is in a different condition from one in its natural state, since electrical charges are continually pouring through it from A and B; and again it is in a different condition from an electrised rod, since we cannot at any moment say that it is charged positively rather than negatively. Hence we cannot infer that it should attract rather than repel an electrised ball D, since there is as much reason for one event as the other, and in point of fact we find that it neither will attract nor repel D. We have here a positive current of electricity issuing from A and a negative from B, and no effect of attraction or repulsion is produced on an electrised point as in statical electricity. How then is its state recognised? *First* by touch; for if we touch the rod A C B, a series of shocks [illegible] felt, the interval between two succeeding ones being inappreciable; and secondly, powerful chemical decomposition may be effected. [GALVANISM; ELECTRO-CHEMISTRY.] But, thirdly, we may recognise it mechanically by presenting to A B another rod A′B′ under exactly similar circumstances, when the effects of the currents in A B, A′B′, will be recognised by the visible motions of the rods, provided they be free to move while their communication with the proper sources of electricity remains unbroken: for example, if their extremities be immersed in cups of mercury communicating with the constant sources of the positive and negative electricities. The laws of the mutual action of electrical currents constitute the science of electro-dynamics; and previous to its study it would be desirable that the reader should be acquainted with the construction and applications of the galvanic apparatus, the opposite poles of which afford the two constant sources (A B) of electricity which we have supposed. These will be found under the head GALVANISM.

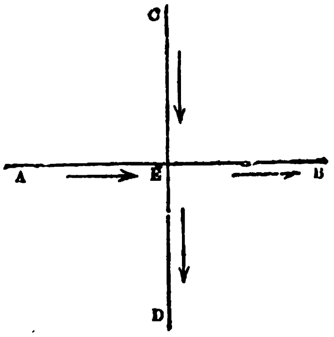




To discover the laws of the mutual actions of electrical currents we must have recourse to experiment. The apparatus required for the purpose is figured in books on physics, together with a description of the mode of performing the various experiments by which these laws have become known. [ELECTRO-MAGNETISM.] The term *direction of a current* is convenient when speaking of more than one; for instance, the zinc end of the pile being a constant source of positive electricity and the copper end of negative, a rod communicating with wires connected respectively with these extremities will have a current of positive electricity from the zinc to the copper, and a negative current in a contrary direction; but as it is simultaneously permeated by both, when we speak of the direction of a current we shall understand that of the positive current to avoid ambiguity.

Two parallel currents which are directed in the same way attract each other, but when directed in opposite ways they repel.

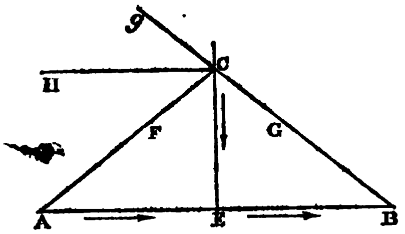
When rectilineal currents form mutually an angle, the species of action which they exercise may be thus defined: "Two portions of currents will attract if they are both approaching or both receding from the vertex of the angle which they form; but when one approaches and the other recedes from that angle, then they repel:" the same law holds in the limiting case of parallelism.



Let two currents cross each other, as A E B, C E D, and suppose the directions of the currents to be those indicated by the arrows in the figure; then, according to this law, the force between C E, E B, is repulsive; and that between C E, E A, attractive; if, therefore, A B is fixed, and C E D moveable, we ought to have C E tending towards A E, and for the same reason, D E tending towards E B; the rod C E D, therefore, has a rotatory motion impressed on it until it is placed parallel with A B: this is confirmed by experiment.

If we now consider two currents to form a very obtuse angle, one of them approaching, and the other receding from the vertex, we have repulsion; let the obtuse angle be increased to 180°, and in this extreme case the two currents merge into one: hence it follows that the consecutive parts of one and the same current exercise a mutual repulsion on each other.

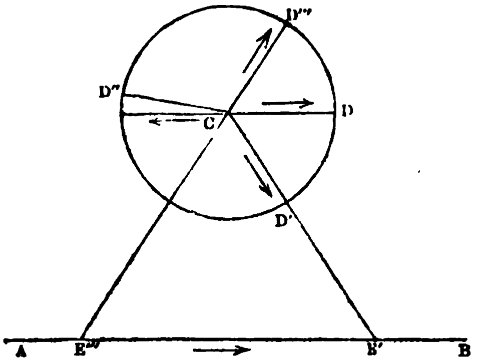
The actions exercised by a rectilineal current and by a sinuous current, which have generally the same direction and are terminated at the same extremities, are equal, the intensity of action being supposed the same in both cases; thus, if we suspend a moveable conductor between a rectilineal and a sinuous conductor disposed so as to repel the first, this, after a little oscillation about its mean place, will finally rest in the middle of the interval between the conductors.



Let us now consider the action of an indefinite current A B, on a terminated current C E, which is directed towards E; the direction of A B being that indicated in the figure.

The portion B E of the indefinite current repels E C, in consequence of the contrary direction of the current in the latter. Let us represent this force in magnitude and direction by Cg=C G; also A E attracts C E; the force may be represented by C F, similarly situated with C G; but Cg, the repulsive force of B E, is drawn without the angle B E C; and C F, or the attractive force of A E, must be drawn within the angle A E C. If we now compound the forces C F, C G, they will manifestly produce a resultant C H parallel to the indefinite current A B. Hence the terminated current will be urged by a force parallel to the other, and in a contrary direction; and by similar reasoning it is easily seen that if the direction of the current C E were contrary to that indicated by the arrow, or receded from A B, then the whole force in C E would be in the same direction as the current A B, and parallel to it.

Let us suppose C D to be a conductor moveable round an axis at C in the plane D D′ D″, and suppose the direction of its current to be from C towards D, and that of an indefinite conductor A B to be similar and parallel; then A B attracting C D will turn it round C into the position C D′, and the force on the angle C E′ B is then repulsive, and in C E′ A attractive; hence C D′ will further turn round, and the same direction of rotation will be continued in the upper semicircle; for the force is attractive in the angle D‴ E‴ B, and repulsive in D‴ E‴ A. Hence a



continued rotation will be produced. This rotation will be in the contrary direction if we change the direction of the current either in A B or C D; or if, without changing the current, we transfer A B to the opposite side of C D: hence if A B be placed so as to meet the axis C, there will be no rotation; hence also if the terminated current be moveable round its middle point there will be no rotation, since both its halves tend to rotate in contrary ways. It is easy to analyse in the same manner the action of an indefinite conductor on a closed current by considering its action on each of the parts, the general effect being to bring the moveable conductor into a position of equilibrium in a plane parallel to the indefinite conductor.

Instead of a single closed circuit we may suppose any number of them connected together after an invariable manner. The action of an indefinite current will still tend to bring that system into a plane parallel to its direction. These systems have been called electro-dynamic cylinders and also canals of currents.

In consequence of the electro-chemical causes which are so widely diffused through the globe, electrical currents are generated, which give its polarity to the magnet, and which, as is well known, are sufficient to generate continued rotation of given currents.

It has been found by Ampère that the actions of similar conductors on points similarly situated are equal; and that a closed conductor exercises no action on a circular conductor moveable round a central axis.

In seeking for the true laws of elementary action of currents, a decomposition similar to that of the parallelopiped of forces may be employed; that is, for the action of an elementary current we may substitute the actions of the three sides of a parallelopiped terminated at the same extremities; for, as before stated, if we preserve the direction of the currents we shall not alter the action by substituting any sinuous for a plane conductor with the same extremities.

We will now show how the law of force between the elements of currents may be obtained, which, when once known, will reduce all the phenomena to mathematical calculation.

To determine the law of force tending to or from any element of an electrical current, when points of another current are taken at different distances but in a given direction:—

Let δs, $\delta s'$ be the elements of two electrical currents, of which the intensities are i, i', their distance a unit, and f the force mutually exercised in the line forming their middle points; hence $f = ii' \delta s \; \delta s'$.

Let $\delta\sigma$ $\delta\sigma'$ be portions of similar currents to the former, but of which the linear dimensions are ν times as great, and since their mutual distance is also ν times as great; this force is diminished in proportion to some function of ν, as $\phi(\nu)$: hence $f' = ii' \delta\sigma . \delta\sigma' . \phi(\nu)$.

$$\text{Now } \delta\sigma = \nu \, \delta s \qquad \delta\sigma' = \nu \, \delta s'; \text{ therefore}$$
$$f' = ii' \nu^2 \delta s \, \delta s' . \phi(\nu).$$
$$\text{Hence } \frac{f}{f'} = \frac{1}{\nu^2 \phi(\nu)}$$

We should have the same proportions if, instead of elements, we took conductors of any lengths but still similar, for this is equivalent merely to integrating the above expressions after decomposing the forces in fixed directions; and since we have experimentally in this case $f = f'$, it follows that $\phi(\nu) = \frac{1}{\nu^2}$; that is, the law is the inverse square of the distance, as in statical electricity; but we must observe that the directions of the currents are here supposed to make given angles with the joining line ν.

The following theorems are taken from Mr. Murphy's 'Electricity,' to which we refer for the demonstrations, which are by no means difficult to persons a little acquainted with the differential and integral calculus.

Let a right line ν join the middles of the elements δs, $\delta s'$ of two currents, being inclined respectively to those elements at the angles θ, θ', the planes of which angles are mutually inclined at an angle ϕ, and let ρ, ρ' be the intensities of the currents; the mutual action of these two elements will then be represented in all cases by the formula

$$\frac{\rho\rho'\,\delta s\,\delta s'}{\nu^2}\left\{\sin\theta,\ \sin\theta'\cos\phi - \tfrac{1}{2}\cos\theta\cos\theta'\right\}$$

$$= \rho\rho'\,\delta s\,\delta s'.\ \ \frac{-}{\nu}{}^{\frac{1}{2}}\frac{d}{ds}\left(\frac{-}{\nu}{}^{\frac{1}{2}}\frac{dr}{ds'}\right)$$

Let $R\ \Theta$, $R_1\ \Theta_1$ be the final values of ν and θ for any given current of which δs is an element, $\delta s'$ remaining as before; then the total action of this electrical current on the element δs in the direction of its length will be

$$\tfrac{1}{2}\,\rho\rho'\,\delta s'\left(\frac{\mathrm{Cos}^2\,\Theta^1}{R^1} - \frac{\mathrm{Cos}^2\,\Theta}{R}\right).$$

This may be easily deduced from the preceding formula.

Hence an indefinite current, for which R, R_1 are infinite, exerts no longitudinal action on $\delta s'$; only a normal force. This coincides with what has been before shown for the action of an indefinite current on a terminated conductor. The same property holds true for a closed current, since in this case $\Theta = \Theta_1$ $R = R_1$.

From hence it is easy to find the total action of a fixed current, or a moveable rectilineal current.

The action of a closed current, or an element of another current, which is turned in all possible positions round its middle point, lies in an invariable plane.

The mutual action of two small closed conductors, containing areas, λ, λ', the centres of which are at a distance ν, exercise on each other a force directly as the plane areas, and inversely as the fourth power of the distance.

The action of a uniform canal of currents indefinitely extended in one way varies inversely as the square of the distance of its extremity from the element acted on, and directly as the sine of the angle which that distance forms with the element, and is in a direction perpendicular to the plane passing through the element and the extremity of the canal.

When two uniform and indefinite canals of currents act on each other, the canals being supposed terminated at one extremity only, the resultant is in the line joining their extremities, and the force is inversely as the square of this line: hence the action of finite canals may be easily estimated, as being the difference between two indefinite canals. With respect to the nature of the force, it will be attractive or repulsive as before described. The simplest mode of observing the actions of a canal of closed currents is by twisting a wire in the form of a helix having but small intervals between the successive convolutions, the action of each portion of the helix being then very nearly the same force as that of a portion of a circle or closed current.

Ampère imagined an ingenious manner of calculating the actions of any plane closed conductors. Conceive one such to be divided into an infinity of small compartments by right lines parallel to the rectangular axes of co-ordinates, and the periphery of each compartment to be traversed by currents, in the same manner as the whole curvilineal side which encloses the area; then it is easily seen that all the internal sides of the compartments, being traversed by two currents in opposite directions, will have no electro-dynamical action, and therefore the sole remaining current is that which circulates in the periphery of the given figure; but by this division into compartments we can calculate the mutual actions of the two closed conductors from the very simple law which we have already given for the action of small closed conductors on each other.

Voltaic conductors, of which the centres of gravity are supported, undergo terrestrial action, similar to that produced by a canal of currents. We should infer, by the position which the moveable conductor takes, that the direction of the terrestrial currents is nearly from east to west, having the north magnetic pole situated on their right.

Since the action of closed currents on an element of a conductor is perpendicular to that element, hence a straight conductor fixed at one extremity, and free to move in a horizontal plane, will receive a continued rotation from the influence of the currents of the earth; but if the conductor were supported by its centre of gravity, it would be brought by their action into a fixed plane, and an electro-dynamic cylinder would come into a position perpendicular to that plane.

All these results of theory are confirmed by experiments, and are shown in the lecture-rooms of gentlemen who profess this branch of science.

With respect to the quantity of the galvanic current, Ohm in 1827 advanced the following formulæ:—1. For a conductor, into whose extremities the two electricitics flow with a given tension. Let A be the electrical tension; K, the conducting power of the wire or other conductor; w, the surface of its transverse section; L, its length; Q, the quantity of the current, then $Q = \frac{AKW}{L}$. 2. For a simple galvanic circuit: Let A be the electro-motive power of the circuit (or the tension?), R, the resistance which the current meets with in the circuit itself. This is the resultant of the following individual resistances: a, resistance of the two metallic plates which the current has to traverse; b, resistance of the liquid through which the current passes. To this, Fechner and Poggerdorff add, c, resistance of transition, or the resistance which exists to the passage of the electric current from the metal to the liquid and conversely. Also, let r be the resistance of the conductor which unites the two metals, and Q, the quantity of the electric current which enters it; then $Q = \frac{A}{R+r}$; therefore, $A = Q\,(R+r)$. 3. For the galvanic battery: n, denoting the number of united simple currents $Q = \frac{nA}{nR+r}$. When the resistance, r, of the conductor which closes the circuit is inconsiderable in comparison with the resistance R, in the individual circuit, it nearly vanishes in the formula, and there remains $Q = \frac{nA}{nR} = \frac{A}{R}$, that is, the quantity of the current is the same, whether it proceed from one pair or from several. But if the resistance of the conductor which closes the circuit be considerable, as from the interposition of water, &c., then Q increases considerably with the number of pairs, because then $\frac{A}{R+r}$ gives a much smaller quotient than $\frac{nA}{nR+r}$. [Galvanism.] See also Gmelin's 'Handbook of Chemistry,' vol. i.; Cavendish Society's Transactions.

ELECTROLYSIS. [Electro-Chemistry.]

ELECTROLYTE. [Electro-Chemistry.]

ELECTRO-MAGNET. [Electro-Magnetism.]

ELECTRO-MAGNETIC MACHINES. [Electro-Motive Machines.]

ELECTRO-MAGNETISM. The first important discovery in point of time, which laid the foundation of this new science, was made by Professor Oersted of Copenhagen. By reference to the article Electro-Dynamics, it will be seen that when the wires which communicate with the poles of a galvanic battery are connected by a conductor or by being brought into contact with each other, the opposite electricities thus continually made to combine acquire a power of action on another conductor under similar circumstances, though latent with respect to common electrical action; but this discovery of Ampère was preceded by that of Oersted, who found that the electrical current thus generated acted upon a magnetised bar, and tended to turn it round as if exercising a tangential force. Before this time a connection between electricity and magnetism had been suspected, or rather believed, by Franklin, Beccaria, and others, from the well-known circumstance that the poles of the compass-needle had been frequently reversed during thunder-storms, and that the same effect could be produced by electrical discharges. In most experiments which were then made these discharges were unnecessarily strong; but to Oersted's discovery, followed up as it has been by Ampère, Faraday, Barlow, Arago, &c., we must ascribe the source of those accurate data by which the actions of the earth on magnets, of magnets on each other, of conducting wires on magnets, and of the earth on conducting wires, are reducible to similar and simple principles of action.

When a magnetic needle is placed near a conducting wire in the plane of the magnetic meridian, and the battery is powerful, it is observed that the needle will turn round, placing itself at right angles to the direction of the current; the same effect, which we have seen in the preceding article, would be produced by the same conductor on a canal of currents. If we suppose that a man with his face turned to the needle is himself the conductor, with his feet at the positive pole, the north pole of the needle will turn towards his right. This must be understood as only meant to illustrate the direction of rotation.

In order to discover the law of action of a current on a magnetic element, Biot and Savart used a small magnetic needle, guarded from the agitations of the air, and having the action of terrestrial magnetism neutralised by a bar, thus subjected only to the immediate action of the conductor. Having acquired the position indicated by Oersted, the times of its small oscillations were observed, which we know by the principles of Dynamics must be inversely proportional *cæteris paribus*, to the square root of the accelerating force impressed. By observing the times in which, for instance, ten oscillations of the needle took place at different distances, it was deduced without difficulty, that the electro-magnetic force exercised by the whole conductor was inversely as the distance of the needle from the conductor; this of course supposes that the current may be regarded as indefinite, compared with the dimensions of the needle. Hence it easily followed, as was shown by Laplace, that the force exercised by each element of the conductor on the magnetic needle must, like all known forces, vary inversely as the square of the distance; and Biot showed that, when the distance was given, the force was then proportional to the sine of the angle formed by each element of the current with the right line joining the middle of that element with the middle of the needle.

It has been shown by means of the multiplier that the electrical intensity of the current at different points of the same conductor is constant. We may observe that the principle of the multiplier consists in bending the wire in the form of a helix, but returning upon itself so as to form a closed circuit, the wire being covered with silk to prevent communications at the crossings; the action of such a spiral being similar to that of closed circular currents equal in number to the spiral convolutions.

It was afterwards found that the magnetic needle of the multiplier could be acted on by electrical discharges from a Leyden jar; and Mr. Faraday showed conclusively that, with the condition of time, ordinary electricity can produce a continued deviation of the needle; this condition he fulfilled by making the electricity pass through imperfect conductors.

Arago observed that small fragments of soft iron were attracted by the conductor of the galvanic pile, and the same current imparted permanent magnetism to small needles of steel. The needle should be placed perpendicularly to the joining wire or current, or, which is better, be introduced in a helix, the discharge of the current through which instantaneously magnetises the needle.

Nobili observed that needles placed between the isolated spires of a plano spiral of copper wire were, by an electrical discharge, magnetised in opposite ways, when near the centre and when near the circumference. Savary also observed that when needles were placed horizontally with their middle points vertical over a horizontal current and the needles perpendicular to the direction of the current, they were differently magnetised according to their distances. These experiments he has varied relatively to the length of the needles, the length and diameter of the conductor, &c.

The magnetising force of the current is transmitted without sensible loss through isolating media, as glass, wood, &c., but is much altered by the interposition of conducting plates, a result similar to the development of ordinary electricity by the influence of electrised bodies. Thus—a large plate interposed between the conductor and the needles weakens the magnetising effect of feeble discharges, while it augments strong ones: and for a given charge, a thin and a broad interposed conducting plate may produce contrary effects, and with a certain determinate breadth the effect would be unaltered, and in general the two surfaces of the same plate exercise contrary actions. (Savary.)

When a bar of soft iron, bent in a horse-shoe shape, is encompassed by a helix covered with silk and always turned in the same way, it may be made to receive a powerful magnetism under the influence of a current through the helix discharged from a voltaic battery. In this way electro-magnets have been formed capable of supporting a ton weight and upwards. The magnetism of the soft iron under the influence of the voltaic current, attains its maximum in a few moments, and ceases immediately when contact between the helix and the battery is broken. On reversing the direction of the current through the helix the polarity of the electro-magnet is also reversed. It is remarkable that the molecular action which we know must take place in magnetising a bar of soft iron has the effect of increasing its length, and at the same time causing it to emit an audible sonnd, the note being such as would be produced by striking one end of the bar. The same note is also produced on breaking contact with the battery when the bar returns to its original dimensions. If these molecular movements be quickly alternated by making and breaking contact in quick succession, there is an elevation of temperature in the bar which is quite independent of the heat of the conducting wire caused by the current.

The great use which is made of the electro-magnet in telegraphy [TELEGRAPH] has led to considerable research as to the most favourable conditions for forming it. According to Lenz and Jacobi, when the voltaic current is of uniform strength the magnetism induced is directly proportional to the number of coils on the bar, which coils may be distributed over its whole length or be accumulated towards its two extremities. Nor is the effect influenced by the diameter of the surrounding coils, for although the induction diminishes as the distance of the magnet from the wire, yet the induction produced by the increased length of the wire in the circumference of the coil is augmented in the same proportion. The thickness of the wire is a matter of indifference, the energy of the magnetism being *cæteris paribus* proportional to the strength of the current, it being directly as the electromotive force, and inversely as the resistance of the circuit. The retentive power of the magnet, like the attractive power of electricity, increases as the square of the intensity of the magnetism. The magnetic effect of a solid bar is proportional to its surface; in cylindrical bars it is as the square of the weight. Now as bundles of insulated wires expose a larger amount of surface than a solid bar, they are capable of a higher magnetic result than a solid bar of equal weight. It is also stated that the only advantage of long bars over short ones is the removal to a greater distance of the two opposite poles from each other.

The discovery of the currents produced by volta-electric induction is due to Mr. Faraday. With about 203 feet of copper wire he formed each of two helices, and twisted them about a cylinder of wood, making one in communication with a galvanometer and the other with a powerful voltaic pile. The moment the communication was established, the galvanometer deviated; then, after some oscillations, returned to its place, and again deviated the instant this communication was broken: hence the directions of the inducing and induced currents are contrary, while that generated at the interruption of communication or cessation of the inducing current is directed the same way with the latter.

The same philosopher has also succeeded in producing currents by the influence of magnets, his experiments with the great magnets of the Royal Society proving most manifestly the disengagement of electricity by the influence of ordinary magnetism. The extraction of the electrical spark from the magnet, as also the continued rotations produced by terrestrial magnetism, are well-known phenomena. [MAGNETO-ELECTRICITY.] The theory of Ampère, which supposes electrical currents to exist round the component particles of magnetised substances, and round the mass of the earth, is perhaps the most satisfactory explanation yet given of the cause of magnetic action, and has been greatly strengthened by the discoveries of Faraday on electro-magnetic induction, by which many objections that had been urged against this theory are removed.

The varied phenomena of electro-magnetism require a good deal of delicately constructed apparatus, a knowledge of the subject, and much careful manipulation, for an account of which we may refer to almost any competent work on natural philosophy.

ELECTRO-METALLURGY. The chief object of this branch of applied science is the deposition of a thin metallic layer on the surface of some other body prepared for its reception; the outer layer being intended generally (but not always) for one of three purposes—the decoration, the protection, or the imitation of that which lies beneath. The mode of proceeding assumes different forms, according to the purpose in view. The names *Electrotype, Galvanotype, Voltatype, Voltagraphy, Galvano-Plastics, Electro-Plating and Gilding*, have been all applied in a somewhat confused manner to different modifications of the art; but we agree with Mr. Smee, that it would be convenient to adopt the term *Electro-Metallurgy* as a general one, including all or most of the varieties.

Under the article GALVANISM will be found an account of the principle of what are termed *batteries*, or arrangements for generating and sustaining electro-chemical currents. If the wire connected with the zinc element of a compound battery have a plate or surface of any conducting substance attached to it, moulded into any form, or having any design or pattern cut upon it, while the other wire terminates in a copper plate of equal surface with the former, both being placed near and parallel to each other, but not in contact, and be immersed in a saturated solution of sulphate of copper, this solution will undergo decomposition; the metallic copper will be slowly and equally deposited on the plate, and will form an exact counterpart or *cast* of the form or pattern. It is the power thus obtained of copying in metals deposited by electrolytic action any form or pattern which is made the negative surface of a voltaic circuit, which constitutes the basis of electro-metallurgy: and it now remains to explain briefly by an example the mode of manipulation to be employed.

Let the object to be copied be a small *bas-relief* of about six inches by four, executed in a material such as marble, ivory, or plaster of Paris, which will admit of a wax mould being taken from it by the usual processes: to do this, the original, if of plaster of Paris, must be well oiled at its surface, to prevent the wax from adhering to it; but the oil must be allowed to soak into the plaster: the wax, which should be of the finest white kind, must be poured on, well melted, and the plaster should be previously warmed to prevent the wax from being suddenly cooled by the contact before the whole surface is covered with it: when cold, the mould may be detached from the original without injury to either. That this mould may be employed as the conducting-plate of a voltaic circuit, its surface must be rendered *conducting*, which the wax itself is not: for this purpose the surface is to be covered over with the finest powdered plumbago, equally and lightly rubbed in by means of a camel-hair pencil; and the success of the operation depends on the face of this mould being equally covered with the plumbago, the back and edges remaining as they were.

An earthenware or wooden vessel of any convenient form is chosen, capable of holding the mould and a copper plate of the same size at the distance of half an inch from it, so that they may be quite immersed in the solution of sulphate of copper: it is better if the mould and plate be vertical in the vessel. The copper plate must have a wire soldered to its upper edge, for the purpose of connecting it with that of the battery, both plates of which should consequently be provided with binding-screws, to allow of these connections being made and broken at pleasure. The wax mould must also be connected with the zinc element of the battery by an intermediate wire, and care must be taken that this wire be in perfect contact at the point of union with the conducting surface on the wax mould; while it obviously must not be so connected as to injure that surface or disfigure it: the plumbago accordingly must be accumulated round the part where the wire is put into the edge of the mould, and continued to the front in a narrow well-defined band.

The mould and the plate being placed parallel and very near to each other, face to face, but not in contact, they must be retained in that position in any convenient manner; but care must again be taken in so doing that there is no contact by any conductor between them. The vessel may then be filled with the saturated solution of sulphate of copper and the wires connected with the battery, the precise size and form of which are immaterial. The whole must now be left undisturbed for from twenty-four to thirty-six hours, at the end of which time, the mould, being detached from the battery and withdrawn, will be found covered over with pure bright metallic copper, rough on the outer surface; but when separated from the wax by gently heating, it will, if the operation has been successful, present a perfect copy of the bas-relief, every line of which, to the most delicate markings, will be found transferred to the metal with more precision and delicacy than could have been produced by a cast made with the copper in a state of fusion. Perhaps few facts connected with the laws of aggregation of homogeneous matter are more striking than the one under consideration, and few facts indirectly afford a more remarkable instance of the chemical divisibility of matter. The infinite gradations of tint produced on a silvered surface coated with vapour of iodine, and acted on by light, in the process of the Daguerreotype, can be copied with the most perfect accuracy by electro-metallurgy; and it must be remembered that these gradations depend solely on variations in the molecular arrangement of a coating of mercury, with which the silver has been amalgamated, by exposing it to the vapour of that metal, too thin to be measured, and defying microscopic power to detect.

In order to admit of the copper during its deposition arranging itself so as to assume a malleable or true metallic texture, it is necessary that the electrolytic action be not too rapid, accordingly the battery should be weak in its action. Among other precautions which should be mentioned is that of not reversing the connections, if at any time during the process they should be broken, to allow of the progress of the work being ascertained; for if this should be done, the current being reversed, the copper previously deposited on the mould will be re-absorbed. And in order to keep up the equable and constant deposit which is necessary to ensure homogeneity in the metallic deposit, the liquid solution, both in the vessel containing the mould and in the battery, must be kept constantly saturated by the addition of fresh solid crystals of sulphate of copper: but in putting these into the former vessel, care must be taken not to let the crystals touch the mould; and indeed the fluid in this vessel should not be disturbed if possible during the process, which is easily insured by placing a sufficient quantity of the salt in the vessel before the commencement of the operation.

The *electrotype*, as the above process was called, was first indicated by Professor Daniell, of King's College, shortly after the invention of the constant battery. He observed that copper deposited upon a plate of platinum produced a coherent sheet, in which the lines and irregularities on the platinum were correctly reproduced by the copper. In 1839, Mr. Spencer, and Mr. Jordan in this country, and M. Jacobi, of St. Petersburg, announced their invention of that process, at least in its main features, as above described. The electrotype at once became a popular pursuit. Thousands of amateurs occupied themselves in copying medals, seals, plaster casts of medallions, vegetable objects, such as twigs, fruit, leaves, seeds, and even insects; but the subject was too suggestive to be neglected by manufacturers, and accordingly, in the following year, Mr. Elkington, in England, and M. Ruolz, in France, began to apply the voltaic battery on an extensive scale to the arts of plating and gilding. Innumerable patents have been granted for new processes, or variations of old ones, and the electric current came to be used not only for depositing copper, gold, and silver from their solutions, but also zinc, tin, lead, platinum, and nickel. Many other metals have also been reduced from their salts by its means when required for special purposes. Original inquirers at home and abroad, have lent their aid in investigating the subject, and the result has been a wide extension of electro-metallurgy to other arts, such as stereotyping and nature-printing; it has been used for making moulds for the foundry, for reproducing printed characters, copper-plates, wood engravings, rollers for the calico printer, copper-plate engravings, daguerreotype pictures, &c. Such are a few of the varied applications of the art, and we will now give an example of one of its important applications, and connect it with some general details.

The electrotype has been used for multiplying large copper-plates, such as those engraved for the Art Union, for which purpose a matrix is first produced, in which all the sunk lines of the original plate are represented in relief in the copy or matrix, and this is used as the parent of succeeding copies. In forming the matrix, a slip of copper is soldered to the original plate, the back of which is covered with a resinous varnish to prevent it from receiving a deposit of the reduced metal, and thus prepared, the plate is lowered vertically into a saturated solution of sulphate of copper, and connected with the negative pole of a voltaic battery, which may consist of three or four of Smee's or Daniell's cells. Connected with the positive pole of the battery is a sheet of copper, equal in size to the one to be copied, and placed parallel to it. The solution immediately begins to be decomposed; metallic copper is deposited on the surface of the negative plate, while an equivalent quantity of copper is dissolved from the positive plate, by which means the solution always retains an equal quantity of sulphate of copper. The process requires watching at the commencement, to see that the deposit is uniform, for should the negative surface be soiled with grease or resin, no deposit will take place in those parts. The solution also requires to be frequently agitated, to prevent it from becoming impoverished about the negative plate, and too much saturated about the positive plate, for should such occur, the unequal density of the solution will cause currents to set in, whereby vertical grooves and striæ will be formed on the back of the sheet of deposited metal. To prevent these effects, the plates are sometimes supported horizontally in the bath, the negative plate being undermost, but in such case the positive plate must be wrapped in flannel to prevent the small particles of metal, which are constantly leaving it, from falling upon the lower plate. When the deposit is sufficiently thick, it is detached at the edges, and can be easily removed.

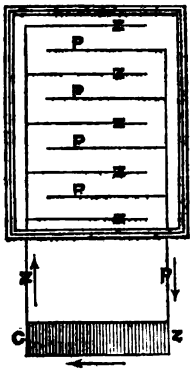
The texture of the deposited plate depends upon four circumstances: 1, the strength of the battery; 2, the degree of concentration of the solution; 3, its temperature; 4, the relative size and position of the two electrodes. As these conditions vary, the deposit may be as hard and brittle as steel, as soft and flexible as lead; of a crystalline texture, and even pulverulent. M. Boquillon has found, other things being equal, that if the positive electrode be of larger size than the negative, the deposit will be crystalline, and if the difference between the two plates be considerable, the deposit may be pulverulent. The contrary effect takes place, if the positive electrode be the smaller of the two. Similar results may arise from an increase in temperature. In the case of the solution, if it be completely saturated, the deposit will be hard and brittle; if less saturated, it will be more flexible, and if weak, it will be spongy, crystalline and even pulverulent. These generalisations, however, do not apply to all the metals, for many of them are thrown down from their solutions in a crystalline form, whether the deposition be made quickly or slowly. Silver behaves in this way when separated from its nitrate, and lead from its acetate and nitrate. Gold and platinum do not form coherent plates from solutions of their chlorides, but it sometimes happens that where the solution of a simple salt fails, good results may be obtained by the use of certain double salts of the same metal, with potash or soda: thus, the double cyanide of gold and potassium is used for gilding, and a similar salt of silver for silvering.

Steel plates do not admit of being copied in the same manner as copper-plates, since the steel and the sulphate of copper solution act chemically on each other, but by first electrotyping the steel plates in silver, which can be deposited without injury to them, and using the silver as a matrix, a copper fac-simile of the original plate can be obtained.

In copying objects which would be injured by immersion in the metallic solution, we have seen that the early electrotypists took casts in wax, and made the surface conducting, by rubbing it over with finely divided black-lead. Casts are now made in fusible metal, stearine, or gutta-percha; in the last case, two parts of gutta-percha, and one part of marine glue should be used, the glue to be melted at a gentle heat and incorporated with the fragments of gutta-percha. In taking a cast, the paste is to be applied soft, and with a gradually increasing pressure. In some cases, an impression of the object to be copied is obtained in sheet lead, by the application of a strong pressure, as for example, in what is called *nature-printing;* suppose a frond of fern is the object to be copied, this is placed between a plate of steel and one of sheet lead and so passed between a couple of steel rollers in a press. The soft lead receives the markings of the plant, so as to indicate its structure very minutely, and from this leaden impression a copper deposit or matrix can be formed, from which other electrotype plates are procured, well adapted for printing. When natural objects, such as leaves, flowers, insects, &c., have to be coated with metal, they are made conducting by being immersed in a weak solution of phosphorus, in bi-sulphide of carbon, or in ether, allowing the solvent to evaporate, and then plunging the object into a solution of nitrate of silver: the phosphorus reduces upon the object a very thin film of silver, which enables it to receive the deposit from the battery when placed in a metallic bath.

In copying small objects, a separate voltaic battery is not required, since the depositing cell may itself be converted into a voltaic couple; for example, an arrangement may be extemporised by means of the chimney of an Argand gas-burner, closed below by means of plaster of Paris, and supported in a vessel containing the sulphate of copper solution. The lamp-glass is to contain dilute sulphu[illegible] acid, and also an amalgamated zinc rod. From this rod proceeds a wire, which supports at its other end in the copper solution the mould or medal which is to be electrotyped. Crystals of sulphate of copper should be suspended in the upper part of the solution to keep it saturated.

Surface-Deposit, in Electro-Plating.—In the common manufacture of table-plate the articles are either made of standard gold or silver, or have a surface of these costly materials laid upon a foundation of cheaper metal; and it is as an improved mode of applying the gold or silver that the electro process has been chiefly introduced. Messrs. Elkington, of Birmingham, have obtained considerable celebrity for their electro-plated and gilt articles. The metal employed by them as the basis is a hard, white alloy of copper, nickel, and zinc, and fusible only at a high temperature; but silver can be readily deposited on brass, copper, bronze, and German silver. If the article is to be produced by stamping or by brazing, the alloy is rolled into thin sheets, which are worked up into form by the stamping-press or the hammer. [CHASING OF METALS.] But when the article is to be cast (which the more elaborate patterns generally are) a wax model is prepared, from which is made a brass cast, or "pattern," and this is carefully worked up by chasing-tools to the proper fineness and delicacy of detail. From this brass pattern is made a sand-mould; and in this sand-mould the article itself is cast in the alloy or white metal. This is made chemically clean by boiling in an alkaline solution, or heating to redness in a muffle, washing, and brushing with sand, and dipping in nitric acid, in order to prepare it for the reception of the silver; for it is an important object in electro-gilding, silvering, and zinking, to obtain a firm adhesion between the newly deposited metal and the object to be covered. In electrotyping, however, the reverse is the case, for adhesion between the deposit and the mould would be fatal to success. In order therefore to be able to detach the metal, it is customary to expose a newly polished article to the air for twenty-four hours before placing it in the depositing cell. In the case of electro-gilding and plating, when the object has been made chemically clean, it is immersed while wet in the silvering bath, represented in plan in the following figure, in which C Z is the battery, P P are rods connected with the negative pole, to which rods the copper wires for holding the articles to be plated are twisted: Z Z are silver plates attached to the positive pole. The silvering solution contained in the bath may be prepared by dissolving cyanide of silver in a solution of cyanide or of ferrocyanide of potassium, although in some cases solutions containing hyposulphite or sulphite of silver are used. A good working solution should contain $\frac{1}{50}$th of its weight of silver, but there is an inconvenience attending the use of cyanide of potassium, arising from the formation of carbonate of potash, which accumulates and interferes with the regularity of the process. If, however, cyanide of calcium be used, an insoluble carbonate of lime is formed, which sinks as fast as it is produced. The plated articles have a dead white or chalky surface, but may be burnished to a brilliant lustre. If, however, a small portion of bisulphide of carbon be added to the bath, the deposited metal has the lustre of polished silver. The thickness of the deposit is regulated by weighing the articles before they are placed in the bath, and once or twice during the process. A deposit of $1\frac{1}{4}$ to $1\frac{1}{2}$ oz. of silver per square foot of plated surface is about the thickness of ordinary writing paper, and is said to wear well. The solution requires frequent stirring, and the strength of the battery is regulated by the experience of the workman.



In electro-gilding, the article is made chemically clean, and placed in a bath of cyanide of gold dissolved in cyanide of potassium. The gilding solution does not usually contain more than 1 per cent. of gold. M. Ruolz brings the cyanide of gold into solution by means of the ferrocyanide or the ferridcyanide of potassium; he has also used the double sulphite of gold and soda, and some other similar compounds. A solution of the double chloride of platinum and potassium in caustic potash has been used for electro-platinising. Patents have been taken out for electro-deposits of silicium, titanium, tungsten, chromium, and molybdenum. Indeed attempts, more or less successful, have been made to obtain deposits of nearly all the metals.

Solid-deposit in Electro-plating.—In this case the mould is formed of a melted composition of glue and treacle, which has, when cold, sufficient elasticity to enable the pattern to be removed from it with facility, however much "undercut" the device may be. From this elastic mould a cast is taken, in a peculiar waxen composition; and this cast, when made conducting, is suspended in a tank containing a solution of sulphate of copper. A layer of copper is then deposited on the surface of the model, of such a thickness that when the waxen model is melted out from within it, the copper may be able to retain its shape unsupported. The result is, that the *inside* of the copper shell represents a mould of the *outside* of the article to be manufactured. The exterior of the copper is protected by a resisting or non-conducting composition, and it is then suspended in a tank containing a solution of silver (or gold, as the case may be); the galvanic current causes the deposition of the gold or silver on the inside of the copper mould; deposition on the outside being prevented by the resisting composition. When a sufficient thickness of the precious metal is thus obtained, the copper mould is exposed to the action of an acid, which gradually eats it away without injuring the gold or silver beneath, and the result is the production of a vessel or ornamental article of pure silver or gold, of the same pattern as the original wax model.

Electro-zinking.—A solution of sulphate of zinc may be used for depositing that metal on iron, much in the same way as the sulphate of copper. Only a feeble current is required, and the operation may be performed on a large scale. In this way the iron links of the Charing-Cross suspension bridge which go into the abutments on each side the river were coated. Each link is 24 feet in length.

Electro-deposit, as a protection or as an ornament.—The deposition of a thin metallic layer on a body prepared for its reception being thus rendered practicable, the applications of the method have become very numerous. It is in most cases as a protection, as an ornament, or as a copy or type, that these applications are intended.

As a protection against damp, &c., Mr. Dent has proposed electro-gilding for chronometer springs, instead of the usual method of "blueing," which he thinks affects their elastic force. A similar suggestion has been made for protecting magnetic bars and needles by the same means. It is surprising how admirably natural objects can be preserved by a metallic coating, and yet preserve all their characteristics. In this way even the exquisite framework of the insect's wings is exhibited almost as distinctly as in the natural state. Mr. Smee says ('Elements of Electro-metallurgy,' p. 222), "The beauty of electro-coppered leaves, branches, and similar objects is surprising. I have a case of these specimens placed on a black ground, which no one would take to be productions of art. . . . When I state that the numerous hairs covering the leaves of a *melastoma,* and even the delicate hairs of the *salvia,* are all perfectly covered, the botanist must at once admit that these specimens have rather the minuteness of nature than the imperfections of art."

In the preservation of all such fruits and vegetables as apples, pears, gourds, grapes, cucumbers, and potatoes, by electro-coppering, a pin is inserted before the immersion, and on this pin being afterwards removed, the hole left by it furnishes an outlet for the sap and moisture from within; and it is found that in many cases the inside dries up completely without deranging the shape of the copper envelope. Ornamental baskets, whether made of wicker or of wire, are coated in a similar manner. So likewise are lace and other articles made of woven fibres. Indeed, should a taste for productions of this kind spring up, the means are at hand for extending the art almost indefinitely; for by a preliminary steeping in a solution of phosphorus, or some other conducting agent, almost any substance may be brought into a state to receive a deposition of metal in a delicate film; and this film may be of copper, silver, gold, platina, or nickel. Porcelain and earthenware might without much difficulty be brought under similar operations.

Electro-deposit as a means of copying. Examples have already been given of this branch of the art; and we may here remark, that the electro-process has been recommended not only for copying engravings, but for making the copper-plate itself on which an engraving is to be executed. The copper-plates prepared for engravers generally contain a small portion of other metals, which render both the engraving and the etching somewhat uncertain; by the substitution, therefore, of plates produced by electro-deposition, in which the copper is quite uncontaminated with other metals, an advantage is anticipated. To produce these plates, a copper-plate is prepared in the usual way and suspended in a copper solution, by which a film of any desired thickness may be produced; and by a previous adjustment of the plate, the new portion may be separated from the old in the form of a distinct plate, susceptible of after-preparation for the engraver. Or, the copper-plate, instead of being made by deposition upon another plate of the same material, may be produced on a flat surface of wax or plaster properly prepared.

Galvanic etching and engraving. The voltaic current may be used for biting in the plates of the engraver instead of dilute nitric acid as usually employed. For this purpose both sides of the plate are covered with engravers' varnish, and the artist etches with a fine point the design on one of the surfaces, cutting through the varnish so as to expose the metal beneath. The plate is then connected with the *positive* wire of the battery, and on completing the circuit the oxygen and acid set free on the surface of the plate will attack those portions which have been laid bare by the tool of the engraver. As a plate etched in the common way is treated with the acid three or four times, to produce different grades of tint; so is likewise the plate etched by the galvanic method. Mr. Smee says that "the advantages of galvanism for etching are, the absence of poisonous nitrous fumes, which are evolved in the ordinary process; the greater uniformity of action which takes place than when acids are used; and the rapidity of biting, which may be regulated to the greatest nicety. The lines may be of any depth, and are sharper and cleaner than when acid is used; and lastly, no bubbles are evolved, which the engraver well knows are apt to tear up the ground, or to cause unequal action."

The terms *Electrotint* and *Glyphography* have been applied to two methods of etching by galvanism, in which the device is produced in rather a peculiar way. The methods are adapted, one for plate-printing, in which the design is in intaglio; and the other for surface-printing, as in common typography. For the former of these two methods, a paint or pigment is used, possessing the properties of working freely, laying on without spreading, and resisting the action of sulphate of copper: a composition of white wax, lard, lamp-black, olive oil, and turpentine, is said to answer well for the purpose. The plate employed is not of copper, but of some mixed metal presenting a white surface, such as one of the modern kinds of German silver. Brushes made of fitch, hog's hair, camel's hair, and sable hair, cut at the ends to various shapes, are employed; as also points of wood, ivory, and metal. The artist sketches his design on the dull white surface of the plate, and then paints the subject in full by means of the brushes and composition. All the parts which are to be white in the impression are left uncovered by the paint, either by handling the brush so as to avoid them, or removing the paint from them by a cork stump or other means; the kind of stroke and the thickness of the paint are made to depend on the depth of the shade in the picture. When the picture is finished, it is coated with black lead, and exposed to the electro-coppering process, by which a plate is produced fit for working in the copper-plate press, having the lines of the device marked in intaglio or sunken.

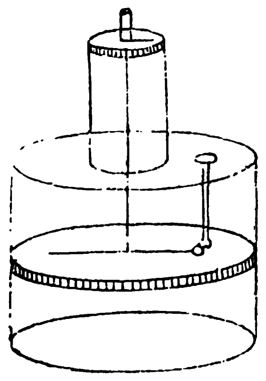
In the surface-printing method, the paint or composition is so laid on as to cause a series of hollows in the electrotype deposit sufficiently deep to prevent being inked by the printer's inking roller; in other words, all those parts which are to be black in the impression are left untouched on the plate—a plan directly the reverse of the former. In order to aid the artist in producing the required effect, he uses a white paint on a black ground; the metal plate may be blackened by hydrosulphuret of ammonia, or by other agents; and a white paint may be formed from a mixture of sulphate of lead, white wax, lard, and olive oil. The mode of pencilling is entirely different from that adopted in the former case, and, as would appear, more difficult; for the artist has to avoid with his pencil all the parts which are to form the device or inked part in the impression. When the plate is finished it is coated with black lead, and immersed in the sulphate of copper; whereby a plate is produced fitted for surface-printing.

Minor improvements have been introduced in these curious branches of art; and specimens of pictures produced by these means have been given in the illustrated newspapers.

In the above article the reader will find an explanation of the scientific principles of electro-metallurgy, with a sufficient amount of detail to render the practice intelligible. More than this ought not to be expected in an encyclopædia article. Should more be desired, we cannot do better than refer to a volume just printed by order of the Commissioners of Patents, entitled 'Abridgments of Specifications relating to Electricity and Magnetism, their generation and applications.' This volume contains between 800 and 900 pages. Referring to those parts which relate to electro-coating, electro-deposition, &c., we have hundreds of patents, and as many applications, from the covering of a fish-hook to the metallising of a human corpse. There are also patents for coating steel pens and pen-holders, the hulls of ships and the ribs of umbrellas, for covering vitrified surfaces and for producing damascene inlaid or encrusted work, for making copper tubes and vessels, mirrors or specula, and artificial teeth and gums, for manufacturing the soles of boots and shoes, chairs, bedsteads, and coffins, daguerreotype plates and gold thread, hinges, mantel-pieces, mathematical instruments and projectiles, spoons and forks, wire gauze; for metallising fibrous materials, for all kinds of ornamentation, for protecting telegraph cables and sepulchral monuments, &c., &c.; to say nothing of printing, engraving, and the various other applications already described or referred to in our article.

ELECTROMETER. This term strictly applies only to instruments adapted to measure electricity; it has however been applied in a more extended sense to those which only indicate the presence of that fluid; but these are more correctly denominated *electroscopes*.

Of the former kind is the *Balance of Torsion* invented by Coulomb, to which we have had occasion to refer in the articles ELASTICITY and ELECTRICITY. The following is a description of this delicate instrument.



A very fine metallic wire, or, which is better, a single thread of silk taken from the cocoon, or, which is better still, a filament of spun glass, is fixed at the upper extremity, and at the lower it supports horizontally a fine needle made of a good non-conducting substance, as gum-lac, to one of the ends of which is attached the body to be electrised, as for instance a small ball of elder-pith; at the top of the suspended string there is placed a plate moveable with friction on a glass cylinder, in which the thread is contained, by which any requisite torsion may be given to the thread, which is shown by an index on a micrometer screw; the body of the large cylinder which encloses the needle is also surmounted with a graduated brass circle. In electrical experiments the index of the micrometer is on its division zero, and the plate is turned round so as to bring the needle and pith-ball to the zero of the graduated circle on the string. Again a second ball is attached to the extremity of a fine isolating cylinder inserted in the apparatus so that both balls may be in contact without pressure. The balls are then electrised by communication with some isolated and electrised body, and acquiring similar electricities repulsion immediately takes place. That attached to the needle being moveable with it, carries it round through a certain angle, and after some oscillations settles at a definite position with respect to the fixed ball, this angle being indicated by the lower graduated arc; the elastic force of torsion is then in equilibrium with the moving force of repulsion between the balls, and hence a measure of the latter can be obtained. In such experiments only a very small electrical charge is communicated to the balls.

Coulomb, in seeking the law of electrical action, found that in the first instance of his experiment the needle deviated by 36°. Then, communicating a torsion to the thread in a direction tending to diminish this deviation, he found that the micrometer index traversed 126° to reduce the angle of deviation to 18°, and 567° degrees of torsion was necessary to bring it to 8¼°; the thread being twisted by forces applied at both ends, it is evident that the entire torsions in the two latter cases are 126° + 18° = 144° and 567° + 8¼° = 575¼°, while in the first case it is only 36°. By comparing the deviations with the torsions, it was easily seen that the force of repulsion varied inversely as the square of the distance between the balls. It should be remembered in such experiments, that if the torsion of the thread be too great its elasticity will act imperfectly, and be no longer proportional to the angle of torsion. [ELASTICITY.]

In like manner the law of attraction of differently electrised balls was ascertained, the torsion being then employed in resisting the attraction. We may observe here that the results thus deduced are necessarily approximative, and not exact, because the neutral electricity of the balls being partly decomposed by the mutual influence of the electricities communicated, the small forces thus arising interfere with the actions which should be due to the latter only. The attractive and repulsive forces may also be estimated by disturbing the needle a little from its position of equilibrium, and observing the number of oscillations which it makes in a given time, as was adopted by Biot in determining the law of electro-magnetic action of a galvanic current.

The proof-plane also used by Coulomb was merely a small disc of gilt paper fastened to an isolating handle; this he employed to discover the distribution of electricity on the surfaces of bodies by touching them with the plane at various points, and observing by means of the torsion-balance the quantity of electricity taken up by contact, which he assumed to be proportional to the quantity of electricity at the point touched.

Various instruments have been constructed for estimating approximately the total quantity of electricity in the charge of an electrised body, such as Lane's, Henley's, and Cuthbertson's electrometers. Henley's quadrant electrometer is represented under ELECTRICITY. The most precise instruments of this description are those invented by Harris: a description will be found in his 'Rudimentary Electricity,' under the names of 'Quadrant Electrometer of Double Repulsion,' the 'Bifilar Balance,' the 'Hydrostatic Electrometer,' the 'Scale-beam Electrometer,' the last of which is represented under ELECTRICITY.

Electroscopes indicate the presence of very small quantities of electricity, and therefore are generally used with a condenser; as in the case of the gold-leaf electroscope, consisting of two small portions of gold-leaf laid flat together; and when made to communicate by a conducting stem, with a condenser which has acquired electricity from a very feeble source, they diverge from each other. They have been also employed to indicate atmospheric electricity. The gold-leaf electroscope is represented under ELECTRICITY.

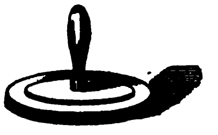
Instruments have also been constructed for the purpose of indicating the existence of electrical currents, a description of which will be found under GALVANOMETER, THERMO-ELECTRICITY, RHEOSTAT, &c.

ELECTRO-MOTIVE MACHINES. The various rotatory motions produced by the electro-magnetic force, and the enormous attractive power developed by electro-magnets have led some ingenious mechanists at various times to seek in electricity a motive power which it was thought would rival even steam itself. A common method of constructing an electro-motive machine was to connect a set of armatures like the spokes of a wheel, so as to revolve horizontally round a point situated midway between the poles of a horse-shoe electro-magnet. In such case the opposite ends of each armature would be attracted by the pole nearest to it, and if the name of that pole were suddenly changed the same armature would be as suddenly repelled. In this way each spoke would be drawn under the poles of the electro-magnet, and immediately driven away with equal force, and the momentum caused by its approaching by attraction, would cause it to pass beyond the attracting pole, an effect which would be assisted by the substituted repulsion. In this way a rotatory motion of the wheel could easily be produced. Unfortunately for so promising a result, these rotations have no permanent momentum, and are incapable of overcoming resistance or doing any work. It is true that an enormous weight may be suspended from soft iron by a very small outlay of chemical force, but there is so rapid a diminution of the inductive force by distance, the magnetic attraction diminishing according to the law of the inverse square of the distance of the surface of the magnet and the armature, that however great the force required to separate the armature when actually in contact with the magnet, their tendency to approach each other when separated is so small that it seems hopeless to expect mechanical effect from this source. For it is only from the strong tendency in these bodies to approach each other that rotation can become a source of mechanical effect. There are also other objections arising from the action of induced electricity to be overcome in these machines.

In the Great Exhibition of 1851, a number of these machines, or their models, were exhibited, and the Jury Report, Class X, expresses rather too flattering an opinion as to their value, especially when it is said, "We cannot help flattering ourselves that the attainment of this mysterious motive force will soon be followed by making it available for practical purposes." About a year or two ago there was a stormy discussion in the 'Times' newspaper, as to the merits of these machines, conducted chiefly by the inventors themselves.

Professor Wheatstone, who generally hits upon the best method of bringing about a result, has contrived what we consider to be the best electro-motive machine. We shall perhaps be able to give a sufficient idea of it in a few words of description. Conceive a number of electro-magnets arranged in a circle with their poles alternating and directed towards its centre. The number of electro-magnets actually employed is eight, so that there are sixteen magnetic poles arranged in a circle. Within this circle is placed a cylinder of iron, not quite concentric therewith. A portion of the outer surface of this cylinder is in contact with the poles of one of the electro-magnets, and the cylinder is free to roll upon them, and to move as they attract it. It is worthy of remark that in this arrangement attraction is alone concerned, repulsion having been got rid of by making the inner cylinder of soft iron, and the objection that the electro-magnetic force rapidly diminishes with the distance is met by making the cylinder roll upon the poles. Now it is ingeniously contrived that as soon as the cylinder, obeying the attraction of one of the electro-magnets rolls upon its poles, it acts upon certain springs, whereby the electro-magnet which attracted the cylinder is unmade, and ceases to hold it, while the next electro-magnet is instantly made and attracts the cylinder, which rolls upon it, unmakes it, makes the next, and so on in quick succession throughout the circle. Connected with the centre of the cylinder, and the centre of the circle of magnets, is a crank which is thus set in motion, and by which it is proposed to impart motion to machinery, &c.

ELECTROPHORUS. An instrument invented by Volta for generating electricity by induction. It consists of a thick disc of resin 12 or 15 inches in diameter, called the *plate*, resting on tin-foil, or cast in a tin plate called the *sole*. The plate is furnished with a metal disc or *cover*, insulated by means of a glass handle. In producing electricity with this instrument the cover is removed by its glass handle, and the plate is excited by flapping it with dry fur or flannel. On putting the cover down upon it a spark of resinous electricity may be drawn from it, and on uninsulating it, and then raising it, it will give a still brighter spark of vitreous electricity. On putting the cover down again, another resinous spark may be obtained, and on touching it and then raising it another vitreous one, and so on for any number of times. In these operations the first action is to give to the resin a charge of negative electricity on its upper surface, while the under surface, being connected with the earth, becomes positive to an equal extent, the particles of the cake being polarised. [Electricity.] The cover being now placed upon the cake, and touching it only in a few points, it is scarcely acted on by conduction, but induction so operates as to throw the under surface of the cover into a positive state, while an equal amount of negative electricity is set free on its upper surface, and this passes off in the form of a spark on presenting the knuckle or other conductor. On raising the cover the + electricity which was retained on the lower surface by induction, is now in excess, and passes off in the form of a spark when a conductor is presented to it. In the mean time the plate which acts by induction has lost none of its charge, and is ready to act again by induction on placing down the cover. The cover must not, however, come into contact with the sole, or the whole of the charge may be drawn off from the plate.



The instrument derives its name from the circumstance of the cover *bearing off* repeated charges of electricity. The electrophorus in connection with the condenser [Electrical Condenser] has had considerable influence in enlarging our knowledge of the most important feature of all electrical inquiry, namely induction. The electrical plate as formed by Volta consisted of equal parts shell-lac, common resin, and Venice turpentine. Pfaff recommends eight parts colophon, one gum-lac, and one Venice turpentine; while Roberts prefers ten parts gum-lac, three of colophon, two white wax, two Venice turpentine, and half a part of pitch. The materials should be well incorporated by stirring up in a pipkin, aided by a gentle heat. Harris remarks that small plates of glass, sealing-wax, or brimstone are well adapted to serve as electrical plates.

ELECTRO-STATICS. [Electricity; Electro-dynamics.]

ELECTROSCOPE. [Electrometer.]

ELECTROTYPE. [Electro-Metallurgy.]

ELECTRUM, from the Greek *electron* (ἤλεκτρον). Pliny says this term denotes two substances, namely, amber and a metallic alloy composed of four parts of gold and one part of silver. "Ubicumque quinta argenti portio est *electrum* vocatur." ('Hist. Nat.,' lib. xxxiii, section 23; 'Hardouin,' tom. ii., p. 619.) The term electron, in the Odyssey of Homer, is supposed to mean amber.

The metallic electrum was in use in the Roman times: it is uncertain whether it was known to the Greeks. The Romans were partial to it for its brilliancy. Pliny, a few sentences lower down than the passage just quoted, says, "Electri natura est ad Lucernarum lumina clarius argento splendere." The Romans used it frequently for what we term plate.

Lampridius, in his Life of Alexander Severus, remarks, that this prince caused coins to be struck in honour of Alexander the Great, both of electrum and gold. "Alexandri habitu nummos plurimos figuravit: et quidem electreos aliquantos: sed plurimos tamen aureos." ('Hist. Aug. Scriptores,' p. 922.)

Isidorus, in his Origines (li. xvi., c. 23), speaks of three sorts of electrum: 1, amber; 2, a metal so called, found in a natural state; and 3, a metal compounded of three parts of gold and one of silver.

ELECTUARY, a term applied to a compound of various medicines, united by means of syrup, or wine, and formed into a soft mass, nearly of the consistence of honey. Substances in the state of powder or extract were thus combined, and rendered capable of being swallowed without their natural taste, which might be unpleasant, being perceived. Formerly electuaries consisted of a great variety of ingredients, often very unsuitable to be taken together. In the present day the few electuaries which are prescribed are much simpler in their composition. Many compounds which were formerly preserved in a soft state are now kept in a hard dry condition, and termed *confections*.

ELEENCEPHOL. A substance found in the brain of man, but now believed not to be a distinct chemical compound, but a mixture of oleine, oleophosphoric acid, cerebric acid, and cholesterin.

ELE'GIT, so called from the entry of its award upon the roll, "quod elegit sibi executionem" (because the plaintiff hath chosen the writ of execution), is a writ of execution first given by the statute Edw. I., cap. 18, but the operation of which has since been greatly extended. It is directed to the sheriff of the county where the defendant's property lies, and commands him to make delivery of the debtor's lands and all his goods (except oxen and beasts of the plough) to the plaintiff.

The sheriff, immediately upon the receipt of this writ, empanels a jury, who appraise the debtor's lands as well as his goods, and if the goods alone are insufficient to pay the debt, then the sheriff, upon the finding of the jury, delivers the lands over to the party suing out the writ, who thereupon becomes what in law is termed a *tenant by elegit*, and continues to occupy them until the whole of his debt and damages are satisfied. The tenant's interest in the land is only a chattel, and as such goes to his personal representatives.

Before the statute of Edward I. a judgment creditor could only have obtained satisfaction of his debtor's goods by the writ of *fieri facias*, and of the present profits of his lands by a *levari facias*; but as the latter writ did not extend to the possession of the lands themselves, a defendant might, if he thought proper, alien the property, and thus oust the plaintiff of his remedy. This has, with other defects, been remedied by the statute 1 & 2 Vict. c. 110.

When the judgment is satisfied out of the estate, the defendant may recover his lands either by an action of ejectment, or by a suit in equity. (*Blackst. Comm.* Mr. Kerr's ed., vol. iii. p. 457.)

ELEGY, from the Greek, *élegos* (ἔλεγος, whence ἐλεγεῖον), in English commonly means a short poem composed on some person's death; also, in a more general sense, any mournful or serious poem, as, for instance, Gray's 'Elegy in a Country Church-yard.' The Greek word, *élegos*, is properly a strain of lament; *elegeion*, the form of versification in which such strains were first composed by the Greeks, that is, the combination of an hexameter and a pentameter (commonly called long and short) verse; *elegeia*, a poem made up of such verses. (Müller, 'Hist. of Lit. of Greece.') The elegiac was the first variation from the hexametral, or epic, measure; and this change of form corresponded with a change of subject: the poet in epic composition keeping himself and the workings of his own mind out of sight; while on the contrary, the free and full expression of the poet's feelings, as affected by external circumstances, constituted the essence of the Greek elegy. Hence arises its variety; the elegies of Callinus and Tyrtæus (the earliest) being political and warlike; of Mimnermus, contemplative and melancholy; of Theognis and Solon, moral and political, &c. It was at first more peculiarly appropriated to social meetings, and therefore equally fit for topics of political and local interest, and for those which refer to the common feelings of our nature, as love, regret for the perishableness of human things, exhortations to the enjoyment of the present hour, and the like. The elegiac was also a favourite measure for epigrams, that is, taking the word in its proper sense, inscriptions. [Epigram.]

Catullus is the first Latin elegiac writer of any note; he was followed by Tibullus, Propertius, and Ovid, with many others of the Augustan age, whose poems are either totally lost, or have only come down to us in fragments. With them political and moral subjects find no place; the elegiac verses of Catullus (a small part of his poems) are, for the most part, either mournful or satirical; those of the other poets above named are chiefly devoted to love, fortunate and unfortunate. Ovid, however, has taken a wider scope of personal feelings in his Epistles from Pontus, and of historical and mythological learning in his Fasti.

ELEMENT. In chemistry this term is applied to such substances as cannot be resolved into two or more simpler kinds of matter. Thus by no analytical processes can anything different from themselves be separated from gold, silver, sulphur, or iron, and therefore these substances are termed elements, whilst potash, common salt, and lime are compounds, because they can be resolved respectively into potassium and oxygen, sodium and chlorine, and calcium and oxygen. Every substance which does not thus admit of analysis must be regarded as an element; in early periods in the history of chemistry many substances were classed as elements which have since been proved to be compounds, and it is not impossible that the progress of knowledge may enable us thus to resolve some of the elements of the present day, nevertheless the probability of such an occurrence is at present exceedingly remote. About sixty-two elementary forms of matter are now known; for a list of them, see ATOMIC THEORY.

ELEMI, a resin, of which there are two or more sorts, brought from different parts of the world, and apparently produced by different kinds of trees. The West Indian or American elemi is commonly referred to the *Amyris elemifera* (Linn.), but the very existence of such a species is doubtful, unless it be synonymous with the *Amyris Plumieri* (Dec.), of the Antilles, and the *Icica Icicariba* of Brazil. The East Indian elemi is obtained from the *Amyris zeylanica*, *Balsamodendron zeylanicum* of Kunth., *Terebinth* (Retz.), while a third sort, called African, or elemi verum, is referred to the *Eleagnus hortensis*. A substance resembling elemi, and capable of being applied to similar purposes, may be procured from several plants. West Indian elemi occurs in irregular-shaped small pieces, which run into masses, of a yellowish colour, of an agreeable odour, which is most perfectly developed by the application of heat. The consistence is at first soft, but it hardens with age, and even becomes brittle, losing some of its odour. Specific gravity 1·083. It seems to contain a principle termed elemine. Elemi is recommended as an ointment, but it is chiefly used to form pastilles, or to burn as incense.

A sealing-wax, into the composition of which elemi largely enters, if applied to cover the tops of the corks of wine bottles, is said to be an efficient preventive of the attacks of the small beetles (thought to be introduced into wine-cellars along with the sawdust sometimes used in packing the bottles), which, eating through the corks, cause the entire loss of the wine. Some believe the destruction of the corks to be caused by the action of the wine.

ELEMI-RESIN. A product obtained from the *Amyris elemifera* of the West Indies, and from the *Ceylanica* of the East Indies. Hess gives the formula $C_{10}H_{16}O$, whilst Rose assigns to it $C_{40}H_{33}O$. Elemi is, however, most probably a mixture. It is known to contain two resins, one soluble in cold alcohol and crystallisable, the other amorphous and containing a less proportion of carbon.

The specific gravity of elemi is 1·03. When distilled with water it yields a limpid, colourless, inflammable oil, which rotates the plane of polarisation to the left, boils between 330° and 345° Fahr., has a specific gravity of ·849, and possesses the same composition as oil of turpentine. With hydrochloric acid it forms an artificial camphor of the formula $C_{10}H_8HCl$.

ELENCHUS, the Latin form of the Greek *elenchos* (ἔλεγχος), and commonly translated by the words *argumentum*, *inquisitio*, *confutatio*, and *demonstratio*, is a term of frequent use in the Aristotelian system of logic, and signifies argument, replication, refutation, or the point, subject, or nature, of dispute or demonstration. (See the authorities cited in Valpy's edition of Stephens's Greek Thesaurus under 'Ελέγχω.) Aristotle defines *elenchos* as "a syllogism of contradiction," that is, an argument alleged in opposition to another; and Mr. Thomas Taylor, in his translation of the 'Organon,' considers the Greek term to be precisely equivalent to *redargutio* in Latin. By some of the early English authors the noun *elench* is used in a similar sense, and also the verb *elenchise*, meaning to argue with captious or sophistical opposition. (Johnson's 'Dict.') In the two last books of the 'Organon,' entitled Περὶ τῶν Σοφιστικῶν 'Ελέγχων, Aristotle minutely classifies and discusses the various kinds of sophistical elenchi, or modes of argument, used by contentious sophists. The sophism which, in scholastic phraseology, is designated *ignoratio elenchi*, that is, a real ignorance of, a mistaking, or sinister deviation from, the argument, or question under discussion, consists in proving something irrelevant, and which, as it may be true without affecting the truth of the real proposition, with which it has no necessary connection, does not determine, though it may seem to determine, the question. Aristotle includes under this designation the introduction of anything extraneous to the point in dispute (ἔξω τοῦ πράγματος); the disproving of what is not asserted, as well as the proving of what is not denied Examples of this species of sophism are of very frequent occurrence in discourses which display the rhetorical artifice of appealing to passions and prejudices, and resort to injurious imputations, or ludicrous and satirical illustration; especially in religious, political, and forensic disputations, which affect individual interests and feelings, and in which the predominant desire is not the exhibition of truth, but merely the obtaining of victory; for a disingenuous disputant when excited, and conscious of the superiority of his adversary's argument, strives to elude conviction by the stratagem of *deploying*, and seeks to gain a sinister advantage and triumph, by proving or disproving, not the real proposition in question, but one or more which in some way are apparently involved or implied, so as to create the assumption of identity. The following instance is given by Dr. Kirwan ('Essay on Logic,' vol. ii. p. 440): "Paschal arguing against atheism insists that it is *more dangerous* than theism, whereas the point in debate is the *truth*, and not the *prudence* of either system. Some Christian sects use similar arguments." Mistake or misrepresentation of the question to be determined, and the consequent proving of what is not to the purpose, are also common in didactic and conversational discussions, and the sophisms of *petitio principii* and *non causa pro causa* are frequently combined with the *ignoratio elenchi*. In all cases of irrelevant conclusion, when something is proved which does not in reality contradict the adversary's proposition, the latent fallacy is best exposed by showing that both propositions may be equally true (Archbishop Whately's 'Logic'); and the best means of preventing sophistical deception of this nature is to keep the attention constantly fixed upon the precise point of dispute, neither wandering ourselves, nor suffering our opponent to wander or make any substitution. (Dr. Watts's 'Logic.') In dramatical writing the *ignoratio elenchi*, or as it is otherwise called, the *quid pro quo*, is frequently adopted as a very effective expedient for the production of laughter. Numerous and long continued instances of consistent dialogue, displaying the most ingenious and amusing *équivoque* or cross-purposes, are to be found in the comedies of Molière, the source of amusement being in each party's "ignorance of the question" about which the other is concerned.

ELEPHANTI'ASIS (ἐλέφας and ἐλεφαντίασις), *elephant* and *elephant disease*, so called partly on account of some supposed resemblance of the diseased skin to that of the elephant, but principally from the formidable nature of the malady. It is disgusting to the sight, says Aretæus, and in all respects terrible, like the beast of similar name.

The term is now commonly applied to two different diseases; first, to a peculiar disease of the skin, one of the most formidable of the dreadful cutaneous affections which occur in hot climates, and more particularly where agriculture and the arts of civilisation are imperfectly advanced; and secondly, to a peculiar disease of the leg, which becoming enormously tumid, is conceived to bear some resemblance to the leg of an elephant.

The first distemper, elephantiasis properly so called, is a tubercular disease of the skin. The tubercles present a shining appearance; they are of different sizes, and are of a dusky red or livid colour on the face, ears, and extremities. The tubercles are accompanied with a thickened and rugous state of the skin, a diminution or total loss of its sensibility, and a falling off of all the hair excepting that of the scalp.

The disease is wholly unknown in this country. It is described as slow in its progress, sometimes continuing several years without materially deranging the functions, but gradually producing an extraordinary degree of deformity. The following is the description commonly given of this formidable malady; but there is reason to believe that the picture is much exaggerated.

The alæ of the nose become swelled and scabrous; the nostrils are dilated; the lips are tumid; the external ears, particularly the lobes, are enlarged and thickened, and beset with tubercles; the skin of the forehead and cheeks grows thick and tumid, and forms la[illegible] and prominent rugæ, especially over the eyes; the hair of the eye-brows, the beard, the pubes, axillæ, &c., falls off; the voice becomes hoarse and obscure; and the sensibility of the parts affected is obtuse or totally abolished, so that pinching or puncturing them gives no uneasiness. This disfiguration of the countenance suggested the idea of the features of a satyr or a wild beast; whence the disease was by some called *Satyriasis*, and partly also on account of the excessive libidinous disposition said to be connected with it; and by others *Leontiasis*, from the laxity and wrinkles of the skin of the forehead, which resembles the prominent and flexible front of the lion.

As the malady proceeds, the tubercles begin to crack, and at length to ulcerate; ulcerations also appear in the throat and in the nose, which sometimes destroy the palate and the cartilaginous septum; the nose falls; and the breath is intolerably offensive; the thickened and tuberculated skin of the extremities becomes divided by fissures, and ulcerates, or is corroded under dry sordid scabs, so that the fingers and toes gangrene and separate joint after joint.

The large misshapen leg, which is also often termed elephantiasis, arises from a repeated effusion and collection of a lymphatic and gelatinous matter in the cellular membrane under the skin, in consequence of inflammation of the lymphatic glands and vessels. The skin itself is much thickened in the protracted stages of the disease, and its vessels become greatly enlarged; its surface grows dark, rough, and sometimes scaly. As the effusion first takes place after a febrile paroxysm, in which the inguinal glands of the side about to be affected are inflamed, and the limb is subsequently augmented in bulk by a repetition of those attacks, Dr. Hendy termed the malady the glandular disease of Barbadoes, in which island it is endemical. In England it is often called the Barbadoes leg. Except when these paroxysms occur, the functions and constitution of the patient are not mainly injured, and they often live many years, incommoded only by carrying about "such a troublesome load of leg."

In this country the disease is only seen in its inveterate stage, after repeated attacks of the fever and effusion have completely altered the organisation of the integuments of the limb, and rendered it altogether incurable. In this state the swelling is hard and firm, does not pit on pressure, and is entirely free from pain. The skin is thickened and much hardened; its blood-vessels are enlarged, particularly the external veins, and the lymphatics distended; and the cellular substance is flaccid and sometimes thickened, and its cells much loaded with a gelatinous fluid. The muscles, tendons, ligaments, and bones, are generally in a sound state.

In this advanced stage the disease is altogether irremediable. Little success indeed seems to have attended the practice employed in the earlier stages, which has chiefly been directed to alleviate the febrile paroxysms by laxatives and diaphoretics, and subsequently to strengthen the system by cinchona. Local bleeding has not been employed; but after the fever and inflammation have subsided, the practice of binding the limb in a strong bandage is strongly recommended as the best means of exciting absorption, and of reducing the swelling. (Dr. Bateman's 'Practical Synopsis of Cutaneous Diseases.')

ELEVATION, ANGLE OF. [ALTITUDE.]

ELEVATION IN ARCHITECTURE. [DESIGN, ARCHITECTURAL.]

ELEUSI'NIA, the great mystic festival of Demeter [DEMETER] celebrated at Athens and Eleusis in the month Böedromion (September): the most important and solemn religious festival of Greece. The lesser mysteries were celebrated in the month of Elaphebolion (March) at Agræ, on the Ilissus, and were a sort of preparation for the Eleusinia.

The great festival began on the 15th Böedromion, and lasted nine days both at Athens and Eleusis. The first day was called the assembling (*ἀγυρμός*); on it all who had been initiated in Elaphebolion were assembled at Athens and invited to complete their sacred duty. The second day was named *ἅλαδε μύσται*, "to the sea ye initiated!" from the words of the proclamation, by which they were admonished to purify themselves. This purification took place in the *ῥειτοί*, two streamlets of salt water running into the gulf of Salamis, and which separated the territory of Eleusis from the rest of Attica. The third day was called *εἰς λέχη μύσται*, from some ceremonies imitative of the marriage of Persephone, which took place on that day. On the fourth day there was a procession, in which a vessel filled with poppy heads and pomegranates, emblems of fertility, was placed on a waggon drawn by oxen, and followed by women bearing other mystic emblems. The fifth was called the "day of the torches," *λαμπάδων ἡμέρα*, on account of a lampadephoria, or torch-procession, in which the initiated, clad in purple robes and crowned with myrtle, marched two and two round the temple, followed by the worshippers bearing torches, symbolising, as is supposed, the wanderings of Demeter in search of Persephone. The initiation took place on the sixth and seventh days of the feast. The sixth day, which was called Iacchos, was the chief day of the Eleusinia. On this day the statue of Iacchos was carried in procession from the Cerameicus to Eleusis, attended by vast crowds of shouting followers. It was during the night succeeding this day that the worshippers were initiated into the inner mysteries. On the following day, which was named the return of the fully-initiated (*νοστοῦσιν οἱ ἐπόπται*), the statue of Iacchos was carried back again, and the initiated returned in procession to Athens, exhibiting the most tumultuous revelry. The eighth day was called Epidauria, in honour of Æsculapius, who did not arrive from Epidaurus to be initiated until after the return of the Epoptæ, and it was observed as a sort of supplemental day of initiation. The ninth day was called *πλημοχόη*. The ceremony of this day consisted in the symbolical overturning of two vessels filled with wine and water, the ceremony being accompanied with certain mystic rites.

The persons initiated at the lesser mysteries were called *μύσται*, from *μυῶ* "to close up," because they were bound to strict silence; those who had passed through the Eleusinian ceremonies were called *ἐπόπται* or *ἔφοροι*, "contemplators," because they had been admitted to see the sacred objects; they were also hailed as happy and fortunate (*εὐδαίμονες, ὄλβιοι*).

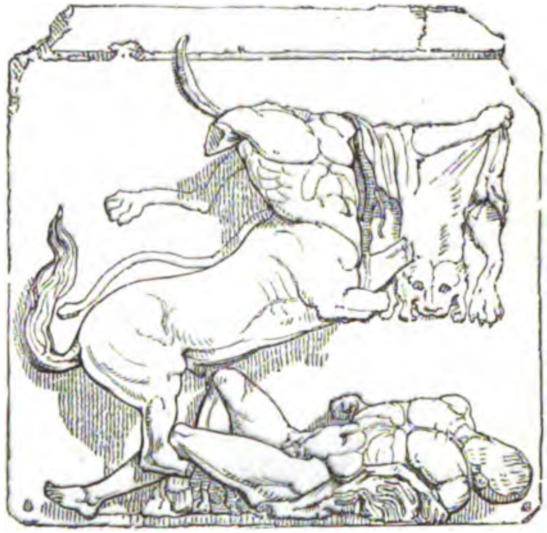
Of the nature of the initiation nothing is certainly known. It is probable that some notions were imparted of a future state of existence. But even this, though stated by early writers, is by no means clear; and there seems to be little ground for supposing with Warburton (Div. Leg. of Moses, b. ii. § iv.) that the ultimate secret was the unity of the Godhead. It may however, from the general tenor of the various references, be inferred that the secrets were of an elevating rather than a debasing character, and that their tendency was to raise the conception of the nature of human life, its purpose, and its duties. Every Athenian was obliged to pass through these ceremonies once in the course of his life. Bastards, slaves, and prostitutes, as well as strangers, and in later times Christians and Epicureans, were excluded from the Eleusinia. To reveal any of the mysteries, or to apply to private purposes any of the hallowed solemnities, was considered a capital crime. The priests at Eleusis belonged to the house of the Eumolpidæ. The chief priest was called the Hierophant, the second in rank the Torch-bearer (*δαδοῦχος*), the third the Sacred Herald (*ἱεροκήρυξ*), and the fourth the Altar-priest (*ὁ ἐπὶ βωμῷ*).

ELGIN MARBLES, the designation given to a collection of ancient sculpture, chiefly from the Acropolis of Athens, whence it was obtained by the Earl of Elgin (who had been the English ambassador to Turkey) between the years 1801 and 1812. This collection was purchased in pursuance of an act of the legislature, dated July 1st, 1816, for the sum of 35,000*l.*, and is now deposited in the British Museum, in what are designated the First and Second Elgin Rooms.

The Parthenon, or Temple of Pallas Athene at Athens, whence the more important of these sculptures were obtained, was built during the administration of Pericles, about the year B.C. 448. It was constructed entirely of white marble from Mount Pentelicus; Callicrates and Ictinus were its architects; and its sculptures were produced partly by the hand and partly under the direction of Phidias.

The sculptures of the Parthenon in the Elgin collection are of three descriptions: Metopes; a portion of the Frieze of the cella; and Statues and their parts from the tympana or pediments.

The *Metopes* are fifteen in number, from the frieze of the peristyle on the southern side of the building, and bear reference to the contest between the Centaurs and the Lapithæ. [CENTAURS.*] There is a sixteenth Metope, placed as No. 9; but it is a cast from one now in the Museum of the Louvre at Paris, the original of which, formerly belonging to the same series, was purchased (for 25,000 francs) for that collection in 1818, at the sale of the Count de Choiseul Gouffier, who before the French Revolution had been his king's ambassador in Turkey. The Metopes are executed in high relief, and are the finest examples of that style in existence. The admirable art displayed in their design and execution, and their exquisite adaptation to the position they originally occupied, have been pointed out in the article ALTO-RILIEVO, col. 252, et seq., where an engraving is given of one of them (No. 2). We add here an engraving of No. 12, which is especially admirable for the accurate expression of the dying Greek



[Metope, No. 12.]

The most interesting of the Metopes are Nos. 3, 11, 12, and 13. The three last mentioned are the finest in point of execution.

In an uninterrupted series of very low relief, placed round the cella, immediately below the ceiling of the porticoes of the Parthenon, was the *Frieze*, representing the solemn quinquennial procession, called the Panathenæa. The procession was represented as advancing in two parallel columns from west to east, one along the northern, the other along the southern side of the temple, and facing inwards after turning the two angles of the eastern front, and meeting towards its centre. Such was the frieze in its original position, when it formed an uninterrupted series of sculptured slabs, 524 feet in extent and 3 feet 4 inches high: the base of the slabs was 40 feet from the floor of the platform. Of its remains the Elgin collection possesses an extent, in slabs and fragments of marble, beginning at No. 17, of rather more than 249 feet, with a continuation of plaster casts of more than 76 feet. The greater part of the last are from portions of the sculpture which were not brought away, including a single slab, No. 23, which likewise belonged to the Count de Choiseul, now in the Museum of the Louvre; all forming a total of representation from the frieze of very near 326 feet. The bas-reliefs which at present compose the frieze in the Elgin Room, as far as they extend, are placed in the same order in which they were originally seen upon the Parthenon. Those on the principal front of the temple, namely, the east, are placed first, then follow those of the north, and lastly those of the west and south. They are arranged, in short, in the same manner in which the spectator viewed them as he approached the temple by the east, and walked round it by the north, west, and south. But the spectator in the Elgin Room has to keep in mind that what formerly surrounded an exterior wall now lines the interior of a room. For some remarks on their artistic character, see the article ALTO-RILIEVO, already referred to.

---

* The two representations of Centaurs and Lapithæ fighting, given under CENTAURS, should have been described as Metopes from the *Theseum*, not the *Parthenon*.

The slabs 17 to 24, form the eastern frieze, the portion which occupied the east end of the temple. The figures on slab 17, the Virgins of Attica, head the procession from the southern frieze. The slab 19, the longest in the collection, stood immediately above the eastern entrance or door, and was the centre of the composition. In this slab, upon the left, a Priestess is represented, supposed to be the wife of the principal archon, or chief magistrate of Athens, in the act of receiving from two canephori, or bearers of the mystic baskets, the articles serving for the rites of sacrifice. To her left stands the Archon, in a drapery which reaches from the head to the feet, receiving from the hands of a youth a piece of cloth folded in a square form in numerous thicknesses, conjectured to be the peplus, or embroidered veil, the sail of the Panathenaic ship, and the principal ornament of the procession. On each side of the groups which represent the priestess and archon are various seated figures, among which Zeus, Pallas Athene, Triptolemus, Æsculapius, and Hygeia are the most conspicuous. Another train of females head the procession as it comes from the northern frieze; and here the sculptures which adorned the eastern front of the Parthenon terminate. This part of the frieze is greatly mutilated; but the explanation of it is aided by some drawings of the Parthenon made in 1674, by Jacques Carrey for the Marquis de Nointel, at a time when the sculptures were a little more perfect. These drawings are in the Imperial Library at Paris, and copies of them are in the British Museum.

From the Nointel drawings it appears that the virgins who led the procession from the northern frieze, like those on the southern side, were followed by oxen led as victims; the foreigners settled in Athens were likewise represented, with the players on the flute and lyre; and a troop of citizens closed the train of persons on foot. But all these have disappeared. Nineteen slabs and a large portion of the northern frieze fell when the Acropolis was besieged by the Venetians in 1687, and these subjects were amongst them. The slabs with which the remains of this frieze now open, Nos. 25 to 31, consist of chariots and charioteers in action, followed by a train of horsemen, Athenian citizens of the second class, who served in the cavalry. This, the most beautiful portion of the whole frieze, extends from No. 32 to 46; in the forms and actions of the horses, in the attitudes and costumes of the riders, and in the distribution of the figures, the sculptors seem to have reached the highest excellence of their art in the department of low relief. (See cuts of No. 45, under ALTO-RILIEVO, col. 257, and No. 39 below.) The bridles of the horses, in many of the slabs here referred to, were originally of gilded bronze, as appears by the holes left in the marble. Small pieces of the bronze itself were found by Lord Elgin's formatori when taking moulds for him from this part of the frieze in its original position.

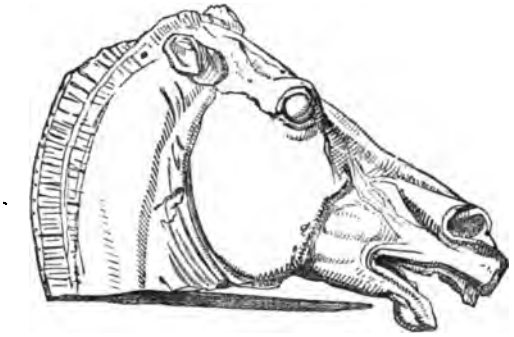
[Slab, No. 39.]

A single slab (but of exquisite beauty, No. 47, see cut of the principal figure, ALTO-RILIEVO, col. 255), is all which the Museum possesses in marble, of the western frieze. Plaster casts of fourteen slabs, which form the remainder of the western frieze, and which are still attached to the Temple, follow it, numbered 48 to 61. The western frieze extended over the front, and over the antæ of the opisthodomos, or back chamber. The direction of the figures is the same as that on the north side, namely from right to left. There is a peculiarity, too, in the frieze of the west end, which distinguishes it from that on the north and south sides of the temple. The subjects represented on the slabs of those two sides run one into another; that is, what was left imperfect in one slab is completed in the next; whereas in the west end the subjects are nearly complete on each piece of marble. The western frieze is likewise distinguished from those of the two sides of the temple by the comparatively few figures introduced into it.

We now come to that portion of the frieze which enriched the southern side of the Temple. The direction of the figures which form it is from left to right, and the numbers being in continuity from the western frieze, begin with the end of the procession, and extend from 62 to 90, round to the door of entrance into the Elgin Room: these slabs have been greatly injured. In this, as in the western frieze, the spectator is supposed to have his face turned respectively to the north and south sides of the temple. A considerable number of the slabs, Nos. 62 to 77, represent horsemen; 78 to 82 consist of chariots; a collection of citizens and old men, corresponding with those of the northern frieze, but more numerous, preceded these; all, however, but a single fragment of four women (No. 83) have disappeared. In the slabs and fragments numbered 84 to 90 we see the sacrificial oxen, and upon the turn of the slab 90 is a figure, believed to be that of a magistrate looking round upon the procession which follows him. He is interposed between the end of the procession on the northern, and the beginning of that upon the eastern frieze. At the end of the room are a few casts of isolated slabs which still remain at Athens.

[The Fates.]

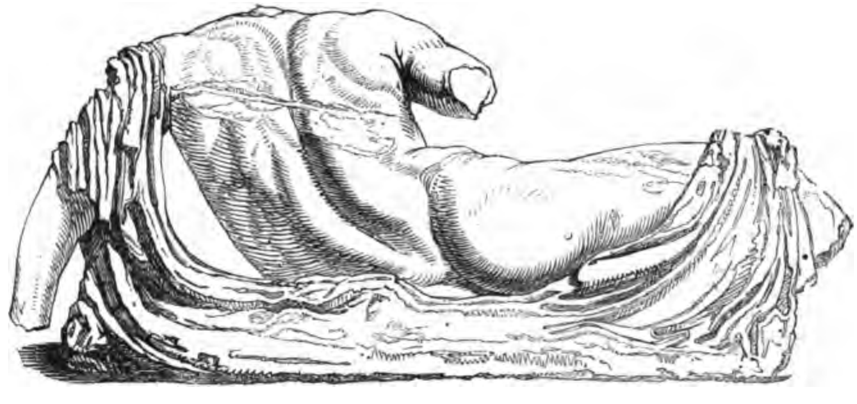
Of the *Statues* and fragments from the tympana, or pediments, of the Parthenon, those toward the southern end of the Elgin Room, Nos. 91 to 98, are from the eastern pediment, the allegory of which represented the Birth of Athene; these consist of the neck, the shoulders, and the arms of the figure of Hyperion rising from the sea, the Horses of Hyperion, the magnificent recumbent statue called Theseus, the goddesses, supposed to be Demeter and Persephone, Iris with her veil inflated, Victory winged, the Fates, and the head of one of the Horses of Night. Those toward the northern end, Nos. 99 to 106, are from the western pediment, the allegory of which represented the Contest of Pallas Athene and Poseidon for the guardianship of Attica. With the exception of the first figure, the Ilissus, or River God, which is one of the finest Greek statues remaining, they are mere fragments, and were broken in an effort to remove them from the pediment after the siege of 1687. The greater part were recovered by Lord Elgin by excavating below a house which had been built out of the ruins beneath the pediment, and which he had purchased. They consist of the torso of Cecrops, a fragment of the face and the chest of Athene, the upper part of the torso of Poseidon, a fragment of the Ericthonian Serpent, the torso of Wingless Victory, and the lower part, or rather lap, of Leto.


[One of the Horses of Night.]

Between, and separating the sculptures of the two pediments (No. 119), stands an imperfect statue of a youth of the size of life, of exquisite workmanship, supposed to have formed part of a group of Dædalus and Icarus; all that is certainly known of it is, that it came in fragments, and from the Acropolis.

Casts from the temple of Theseus, and others from the bas-reliefs of the choragic monument of Lysicrates, are let into the eastern wall of the Elgin Room, the first above; the latter at the northern end, below the Panathenaic frieze.

Of the remainder of the Elgin collection, it may be sufficient to name a few marbles of highest character, such as the colossal statue of Dionysus, from the choragic monument of Thrasyllus, No. 111, and the Caryatide, from the Temple of Pandrosus, No. 128, engraved under CARYATIDES, col. 639. Of architectural fragments, the pieces of friese from the treasury of Atreus, at Mycenæ, Nos. 177, 180, are the most ancient; the capital and portion of a shaft, No. 112, give a notion of the magnitude of the columns of the Parthenon; and the capital and shaft from the temple of Erectheus, No. 126, present the most beautiful example of the Ionic order now known. The fragment of the frieze of the temple of Erectheus is also one of the most valuable parts of the collection. Among the inscriptions, the Sigean, written in the most ancient Greek characters, and in the Boustrophedon manner, No. 107, claims the first place, followed by numerous others relating to the temples and buildings of Athens, some containing decrees or treaties, and a few inventories of the treasurers of the Parthenon: sepulchral inscriptions, urns, and stelæ abound in the collection; and among these the epitaph on the warriors who fell at Potidæa. (Thucyd. i. 63.) Votive bas-reliefs and offerings are also preserved in it in large number. The last article we shall name is a vessel of beautiful form, an urn of bronze; it was found in a tumulus situated on the road which leads from the Piræus to the Salaminian ferry and Eleusis, enclosed within the marble vase in which it now stands, and in it was a deposit of burnt bones, a lachrymatory of alabaster, and a sprig of myrtle in gold. It is supposed, from the last article, to have contained the ashes of some amatory poet.


[Ilissus.]

The possession of the Elgin collection has established a national school of sculpture in our country, founded on the noblest models which human art has ever produced. A tribute of gratitude is due to the memory of the nobleman to whose exertions the nation is indebted for it. If Lord Elgin had not removed them, the greater part would long since have been totally destroyed. In the last siege of Athens the Parthenon suffered additional damage.

ELIMINATION. This word is from *eliminare*, to drive out of doors, and it is used in mathematics to signify the formation of an equation or equations which do not contain a certain quantity, by means of given equations which do contain that quantity.

The simplest case of elimination, and therefore the best adapted for the explanation of the term, is the following: if A be equal to B and B be equal to C, then A is equal to C. In the result, B is eliminated. Any operation of algebra may produce elimination. We give four instances in which such a result is obtained by addition, subtraction, multiplication, and division.

1. $x+y=12$, $x-y=8$; add, $2x=20$: y is eliminated.
2. $x+z=a$, $y+z=b$; subtract, $x-y=a-b$; z is eliminated.
3. $xy=a$, $\frac{2x}{3y}=b$; multiply, $\frac{2}{3}x^2=ab$: y is eliminated.
4. $xy=a$, $yz=b$; divide, $\frac{x}{z}=\frac{a}{b}$: y is eliminated.

The process of elimination, in the case of more complicated equations, becomes difficult and frequently impracticable. So much is this subject connected with the theory of equations, that a treatise on the first would be the largest portion of one on the second. The writings on this subject are scattered, but most works on algebra contain all that is absolutely necessary.

Elimination is an essential part of very many mathematical processes: and in the present article, we can only attempt to give a few general notions, such as may help a student to connect different portions of his algebraical reading.

If the solution of equations were perfect, so also would be elimination. Having 10 independent equations for instance, each containing x, y, and z, if we could choose any three, and from these three find x, y, and z, we might substitute these values in the remaining seven equations, and thus form seven equations independent of x, y, and z. The general rule is that from m equations can be formed $m-n$ equations with n quantities eliminated. But not only must the equations be independent of each other, but no two or more must be capable of what we call simultaneous elimination. Suppose, for instance, x and y never enter into a set of equations except in functions of, say, x^2+y^2. If then we make $x^2+y^2=p$ and substitute, we have a set of equations not containing either x or y, but containing p. If by means of one of these we eliminate p from the rest, the process which does this, applied to the original equations, would allow of our eliminating both x and y by one equation only.

As to equations which are not purely algebraical, or which contain more than powers or roots, or combinations of them, we cannot pretend to say that there is any organised method of elimination existing, except that of solution. For example, we can eliminate x between the equations $x=\log(x+y)$, and $\sin(x+y)=e^y+x$, because it so happens that we can find y from the first, as in $y=e^x-x$; and this value of y may be substituted in the second. But if the first equation had been $x+2y=\log(x+y)$, we could not have found either quantity in *finite* terms of the other, from either equation. In such a case, we must have recourse to infinite series; with these instruments, elimination is always theoretically possible. But whether the results produced will be convergent, and otherwise convenient for use, must depend upon the circumstances of each case. When, however, elimination is spoken of, elimination in finite terms is generally understood.

Let us now take simple algebraical equations, and suppose a pair of them, containing x and y, as $xy^2-x^3y-2=0$, $y^2+x^3y-6=0$. Let these be $P=0$, $Q=0$, and proceed as in finding the most complicated common divisor of P and Q. And first, let it appear that there is a common divisor R, and let $P=RA$, $Q=RB$; so that A and B have not any common algebraical divisor. These equations may then be both satisfied by making $R=0$, which being only one equation between x and y, admits of an infinite number of solutions. But they may also be satisfied by $A=0$, $B=0$, the method of treating which falls under the next case.

Secondly, let there be no algebraical common divisor. Then, if we take y as the principal letter, there will at last be a remainder which is a function of x only: let this be X. Now it is easily proved that when P and Q vanish, X must vanish also: that is, no values of y can make both P and Q vanish, except in combination with values of x which make X vanish. All the required values of x, then, satisfy $X=0$. But is the converse true, and are all the roots of $X=0$ capable of combination with values of y, so as to satisfy both equations? This question will require some consideration.

In the preceding process, when y is made the principal letter, we have generally this alternative, either to introduce fractional functions of x into the result, or else to employ multipliers beforehand to avoid it: these multipliers will be functions of x. Let us allow of fractional functions of x, and suppose the process to be as follows:—

$$\begin{array}{llll} P\,)\,Q\,(\,M_1 & & & \\ & N_1\,)\,P\,(\,M_2 & & \\ & & N_2\,)\,N_1\,(\,M_3 & \\ & & \quad X & \end{array}$$

We have then—

$$\begin{aligned} Q &= M_1\,P + N_1 \\ P &= M_2\,N_1 + N_2 \\ N_1 &= M_3\,N_2 + X \end{aligned}$$

Take a value of x which makes X vanish, and with this value of x, find a value of y which makes P vanish. We have then $Q=N_1=M_3N_2=-M_3M_2N_1$, or $N_1\,(1+M_2M_3)=0$. If then $1+M_2M_3$ should not happen to vanish, we must have $N_1=0$, or $Q=0$; that is, a root of $X=0$, combined with a value of y which makes $P=0$, also makes $Q=0$. But if it should happen that $1+M_2M_3=0$ is satisfied by the values of x and y, we have not this assurance that $Q=0$. Again, if M_1, M_2, or M_3, be made infinite by the value of x, the whole process fails. All we can say then is, that though $X=0$ must contain among its roots all the values of x required, it may possibly contain other values.

Next, suppose we introduce a multiplier to avoid fractions. Let it be convenient to begin with QZ and P, instead of Q and P. Then when QZ and P both vanish, X vanishes; but we can now only say that the roots of $X=0$ may, with proper values of y, satisfy one or the other of the systems $Q=0$, $P=0$, or $Z=0$, $P=0$. But if we take values of x which make $N_2=0$, $X=0$, it is easily seen that we satisfy both $P=0$ and $Q=0$, if no one of the quotients become infinite.

We shall take the following example, to show how comparatively complicated the results of a very simple instance may be. Let the equations be

$$P=xy^2-x^2y-2=0,\quad Q=y^2+x^3y-6=0$$

Multiply Q by x, to prepare for division without fractions, and divide by P: the remainder is $x^2\,(x^2+1)\;y-(6x-2)$. Multiply P by $x^2\,(x^2+1)^2$ for a similar reason, and divide by the remainder. The second remainder, X, is—

$$2x^7+6x^6+2x^5+6x^4-36x^2+24x-4$$

One of the roots of this is $x=1$, with which it will be found that $y=2$ satisfies the equations $P=0$, $Q=0$. And in this instance it does happen that all the seven roots of X are capable, each with its proper values of y, of satisfying the given pair of equations.

If we take the principal letter to be x, the problem of ordinary algebraical elimination is reduced to eliminating x from two such equations as $ax^m+bx^{m-1}\ldots=0$, and $px_m+qx^{m-1}+\ldots=0$, where a, p, &c., are functions of the other letters. The mode which we have always adopted as most convenient in practice is as follows:—Suppose the equations to be

$$\begin{aligned} ax^3+bx^2+cx+e&=0 \\ px^3+qx^2+rx+s&=0 \end{aligned}$$

Multiply by p and a, and subtract, which gives an equation of the form—

$$Ax^2+Bx+C=0$$

Multiply by s and e, subtract, and divide by x, which gives another equation of the form—

$$Px^2+Qx+R=0$$

Repeat the same sort of process, making the first terms destroy each other, and then the last; we are thus led to two equations of the first degree, from which x may be at once eliminated. The same method will do when the equations are of different degrees, but in that case it is more convenient to bring down the higher to the lower, first, in the following manner:—Suppose the equations to be $ax^7+bx^6+cx^5+ex^4+\ldots=0$, and $px^4+qx^3+\ldots=0$. Multiply by p and by ax^3, and subtract, which gives a new equation of the form $Ax^6+Bx^5+\ldots=0$. Multiply by p and by Ax^2 (using the lower of the given equations), and subtract; and continue this process until a second equation of the fourth degree is found: after which proceed with the first and last terms as before.

The problem may be reduced to that of elimination between purely linear equations, as follows: Suppose it required to eliminate x between $ax^2+bx+c=0$, and $px^3qx^2+rx+s=0$. Multiply both these equations by x, and we have then four equations involving the first four powers of x. Multiply again by x, which gives six equations involving the first five powers of x. Let these five powers be considered as five distinct quantities, x_1, x_2, x_3, &c., and eliminate these five quantities between the six linear equations, which are

$$\begin{array}{ll} ax_2+bx_1+c=0 & \qquad px_3+qx_2+rx_1+s=0 \\ ax_3+bx_2+cx_1=0 & \qquad px_4+qx_3+rx_2+sx_1=0 \\ ax_4+bx_3+cx_2=0 & \qquad px_5+qx_4+rx_3+sx_2=0 \end{array}$$

Since two equations are introduced at each new step and only one new power, there must be a step at which the number of equations becomes equal to the number of powers, after which, at the next step, the number of equations will be in excess by one, which is what is wanted for elimination. It is also worth notice that if we were to stop at the step at which the number of equations is the same as that of powers and find the powers as independent quantities, we might then eliminate between the first and second power, and produce the result in the form $A^2-B=0$.

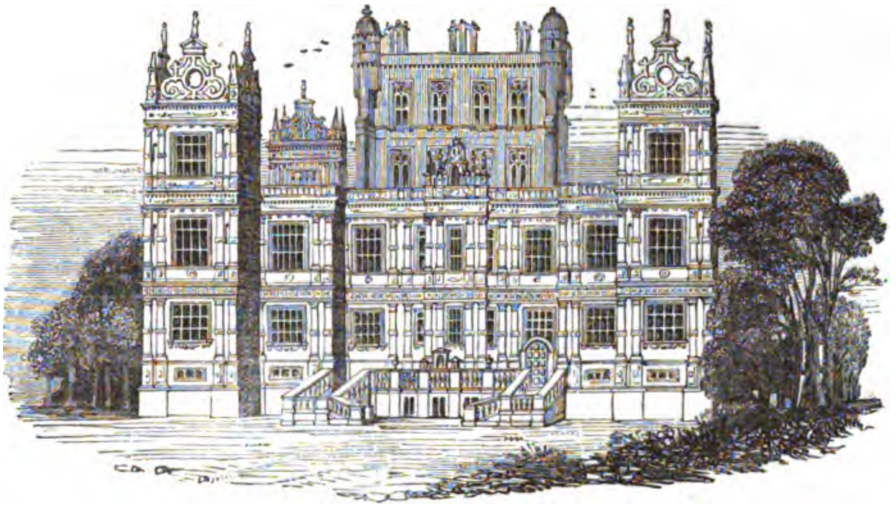
The following method, troublesome enough in actual operation, is the theoretical conquest of the difficulty. Let $\phi\,(x_1 y)=0$, $\psi\,(x_1 y)=0$, be two algebraical equations; and let the values of y from the first be X_1, X_2, X_3, &c. The equation which indicates that the second equation is satisfied by some root of the first is $\psi\,(x_1 X_1)\,.\,\psi\,(x, X_2)\ldots\ldots=0$; and the first side, being a symmetrical function of X_1, X_2, &c., can be expressed in terms of the coefficients of powers of y in $\phi\,(x_1 y)=0$, without actual solution. Let this be done, and we have that equation involving x only which is the necessary consequence of the two given equations.

On this subject see Dr. Peacock's 'Algebra,' vol. ii. cap. 44; or Mr. Sylvester's remarkable papers, 'Phil. Mag.' Dec. 1839, Feb. 1840, June 1841; also 'Cambridge Mathematical Journal,' vol. ii. pp. 232, 276, vol. iii. p. 183, vol. iv. p. 9.

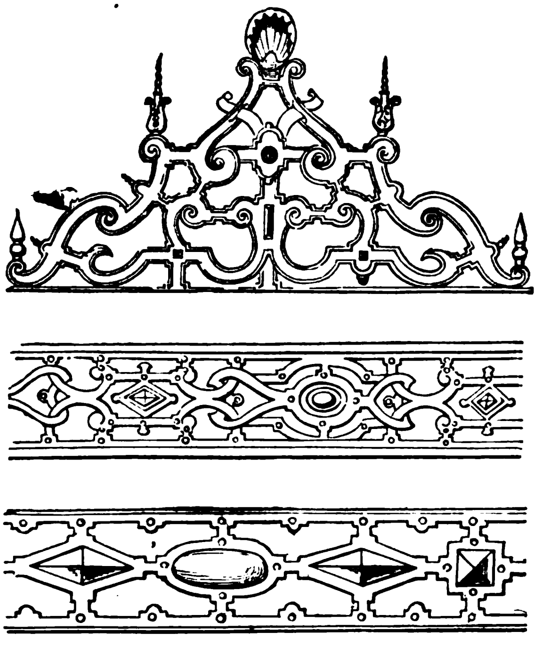
ELIXIR OF VITRIOL. [SULPHURIC ACID.]

ELIZABETHAN ARCHITECTURE. By this name is commonly distinguished that transition style which prevailed in England from about the middle of the 16th to the end of the first quarter of the 17th century, and was accordingly in its meridian during the long reign of Elizabeth. If it were worth while to disturb a name already fixed, it might with perhaps greater propriety be termed the *English Renaissance*, it being a style formed out of the Continental Renaissance engrafted upon our own Tudor and Old English domestic styles; and it was applied exclusively to secular and chiefly to domestic buildings, in which respect it was very differently circumstanced from the Gothic styles, which were almost as exclusively ecclesiastical in character and purpose. The age of Elizabethan architecture was that of palace-building, not church-building; and a style developed itself which was eminently palatial in many of its qualities,—certainly not deficient in stateliness (one very important ingredient),—nor more deficient in picturesqueness.

It is unjust to speak of Elizabethan architecture, as is sometimes done, as being marked by the introduction of the Grecian orders, those employed in it having nothing whatever in common with the orders of antiquity but that sort of resemblance which renders us all the more sensitive of the prodigious difference between the respective styles. Considered as classical or antique, they can be regarded only as grotesque parodies, since the application of them in all the varieties of the Renaissance style is as contrary to the practice of the ancients as their character is dissimilar. The orders are employed merely as decoration, and then only for the separate stories of an edifice, or for distinct compartments of a front. Hence they are invariably microstyle, and are still further reduced in height by being placed on tall pedestals, and look all the smaller owing to the spacious proportions of the windows between them. In fact they are to be regarded only as accessories and decorative filling-up, for they have scarcely even the apparent character of columniation. In point of design, too, they retain little of the orders after which they are named: with the exception of one or two distinctive marks, such as the Doric triglyphs, and the forms of the respective capitals, they are all assimilated in character, the Doric being frequently quite as slender and as much embellished or more so than the Corinthian. Pedestals are mostly panelled and filled in with ornament, the panels themselves being multiplied in a variety of patterns. The shafts of columns are frequently enriched with one or more bands (either sculptured or plain), and the lower part of the shafts is often covered with arabesque carving. Pilasters are similarly treated—sometimes banded, sometimes panelled, and frequently filled in with arabesques or other ornaments, among which raised facetted blocks are very common ones. Entablatures are almost invariably made to break over columns, and are so crowded with mouldings and other carvings as to have the look of being all cornice. Orders are usually applied only to parts of a front; for instance, the centre, which is marked out as a lofty frontispiece or portal ornamented with several tiers of columns, and thus not only distinguished from the rest, but in many instances rendered quite distinct from it, all besides being comparatively genuine Tudor, without any intermixture of foreign elements. Even where such is not the case, the Tudor physiognomy manifests itself in windows and bays, which last are almost as peculiar to our English architecture of the period as small circular towers and turrets with conical or spire-like roofs are to that of Flanders and France. Although square-headed, and without tracery of any kind, the windows retain a good deal of the latest Gothic or perpendicular character, being divided by mullions and transoms into numerous compartments after the manner of panelling, a mode that freely admits of a window being made of any extent; and not only are single windows sometimes exceedingly spacious, but they are put so closely together as to render the whole of a front nearly all window. This fashion, which however is only an occasional variety of the style, is strikingly exemplified by Hardwick, Derbyshire, and by what is called "the Duke's House," at Bradford, Wilts. The front of this latter building is made up entirely of windows and bays, in a manner that would be too monotonous, were not the plan-line broken by semicircular projections being thrown out, as smaller bays, from the larger ones. Thus the design acquires a pleasing playfulness of form; and it is besides not only marked by perfect regularity of composition, but also by a certain compactness, the windows not having the appearance of being intended for separate openings squeezed together for want of more space. The parapets upon the bays, consisting of fanciful openwork, enhance the general richness of effect, and both they and the parapetted terrace serve to indicate what are pleasing peculiarities in the style. A more characteristic Elizabethan mansion is Wollaton, Nottinghamshire, of which we give an engraving. Among the most magnificent palatial residences of this period are Longleat, Burleigh, Hatfield, Holland House, Kensington, and Hardwick, mentioned above. The building here given by way of specimen affords a good example of the characteristic Elizabethan gable, a feature so singularly diversified that to exhibit only the leading varieties of it would require a series of cuts, beginning with the simplest and proceeding to the most complex forms. We give one other example of an Elizabethan gable; but it is necessary to say that almost every imaginable combination of curves, both concave and convex, with straight lines and angles, are to be met with in gables of this period. Differently shaped gables often occur in the same building, and produce great effect of outline, which is increased by embellished parapets, with balls and other ornaments upon them, by small domes on turrets, and by chimney-shafts, all which, mingled together in glorious confusion, often give an air of picturesque magnificence to what are otherwise rather plain and homely structures, and impart animation to what would else be lumpish masses. In like manner, porches and balustraded terraces often give much character to the lower part of a building, while the upper may be comparatively flat and uninteresting.



Wollaton House, Nottinghamshire.



[Gable Scroll-work, from Richardson's 'Elizabethan Architecture.']

The plan of an Elizabethan manor-house is often that of two projecting wings and a central porch,—so often, indeed, that it has been supposed that it was intended, in compliment of Elizabeth, to represent the letter E, the initial of her name: a not unlikely thing, as it was not unusual to make the plans of buildings allusive. John Thorpe, the great English architect of the Elizabethan age, designed a house for himself which was to take the form of his own initials, J. T.: the drawings are in the Soane Library. To the internal characteristics of the Elizabethan style belong spacious bay-windows; long and ample galleries, but generally of low proportions; massive and elaborately sculptured chimney-pieces; screens of similar character, either with open arches or doors; wainscoted and panelled walls; ceilings highly enriched, and sometimes arched, and entirely covered with scroll-work foliage; and wide staircases with richly carved balustrades, and heraldic figures of animals at the angles, were important features in the general design.

The prevailing character is that of heaviness and stateliness, on which account it is ill-suited for literal imitation at the present day, especially for houses upon a moderate scale, or for small rooms. In external architecture many of the defects of detail are merged in the picturesque impressiveness of the whole; but a similar degree of capriciousness and heaviness brought near to the eye within a room, is apt to strike chiefly as too rudely grotesque and ponderous; besides which it is an expensive style for internal finishings, for though it will very well bear to be greatly refined upon, it hardly admits of being simplified, decoration even partaking of gorgeousness being almost indispensably necessary to conceal the native uncouthness of both forms and proportions. Still, a judicious modification, or rather perhaps a free development, of the style is well adapted for brick and stone, such contrast of colour seeming natural to it, and serving to bring out the several parts more distinctly. We hardly need observe that the brick ought invariably to be red, and of superior quality and execution; for white or yellow bricks are so far from producing a similar effect, that they have both an insipid and mean appearance, the building seeming at a distance to be of stone, and when approached discovered to be of an inferior material. The brickwork itself is often variegated by the intermixture of darker bricks, so disposed as to form a regular pattern on the walls, generally consisting of intersecting diagonal lines. There are also many instances of brick alone being employed, the ornamental members being formed of moulded bricks; and though the effect is comparatively sombre, it is by no means unpleasing.

[Staircase at Claverton, Somersetshire, from Richardson.]

(Richardson, *Architectural Remains of the Reigns of Elizabeth and James;* Shaw, *Elizabethan Architecture;* Nash, *Old English Mansions*, &c.)

ELL (Ulna), a measure of length now almost disused. "It is properly," says Ducange, "the length between the ends of both the extended hands, though Suetonius makes it to be only one cubit." It is not worth while to attempt to follow a measure of secondary importance through its various changes, and this measure in particular has denoted very different lengths in different countries. The three ells which have preserved a place in our arithmetical works, namely, the Flemish, English, and French ells, are respectively three, five, and six quarters of a yard.

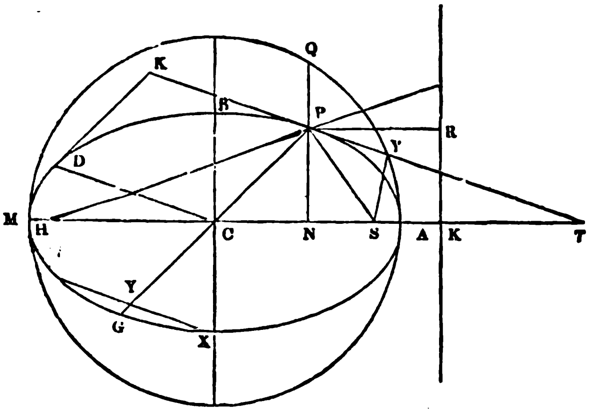
ELLAGIC ACID ($C_{14}H_2O_7,HO$). This acid exists in the gall-nut along with gallic acid; and they are deposited from the aqueous infusion in the state of a yellowish crystalline mass. The two acids are separated by boiling water, which dissolves the gallic acid, and leaves the ellagic unacted upon, but mixed with a little gallate of lime. By treatment with a weak solution of potash the ellagic acid is dissolved, and the gallate of lime remains insoluble; the ellagate of potash is then treated with hydrochloric acid, which uniting with the potash, precipitates the ellagic acid in a pulverulent state. Ellagic acid is also a constituent of certain intestinal concretions which occur in the wild goat, deer, &c., of central Asia, and termed bezoars. Hence this acid is sometimes called *bezoaric acid.*

The properties of this acid are the following. It is of a light fawn colour. It is insipid, sparingly soluble in boiling water, and reddens litmus paper slightly. When heated in close vessels it decomposes, yielding a yellow vapour, which condenses in crystals of the same colour. This acid becomes of a blood-red colour by digestion in nitric acid, and is converted afterwards into oxalic acid. It unites with potash, soda, and ammonia, to form neutral salts; the two first are insoluble in water, except when an excess of base is present; and the ellagate of ammonia does not dissolve under any circumstances. Its acid powers are weak, for it is incapable of decomposing the alkaline carbonates. [BEZOARS.]

ELLIPSE (ἔλλειψις). This curve, which is one of the CONIC SECTIONS, ranks next in importance to the circle (which is in itself an extreme form of the ellipse) and the straight line. We shall here consider the ellipse independently of the other conic sections, and simply state some of the most remarkable properties which can be exhibited without algebraical symbols.

1. Let any two points S and H be taken, and their distance bisected in C. Set off C A and C M, equal lines, each greater than C S, and let a point P move in such a manner that H P and P S together are always equal to A M. The curve described by the point P is an ellipse.

2. C A is called the *semi-axis major*, C B the *semi-axis minor*, C the *centre*, S and H the *foci*, S P and H P the *focal distances* of the point P, C P the *semi-diameter* of the point P, and C D (drawn parallel to the tangent P T) the *conjugate semi-diameter* or *semi-conjugate* of C P. Also the fraction which C S is of C A is called the *excentricity* of the ellipse.



3. Let S A be to A K as C S to C A. Then K R is called the *directrix* of the ellipse, and S P is to P R as S A to A K.

4. The tangent P T bisects the angle made by S P and the continuation of H P.

5. C A is a mean proportional between C N and C T.

6. If, A and M remaining the same, the figure of the ellipse be altered by varying S and H, the tangents drawn through the several points in which the ellipses cut N Q will all pass through the same point T of the axis. The circle A Q M is the extreme form of the ellipse, when S and H meet in C: and the tangent at Q passes through T.

7. Wherever the point P may be taken, N P bears to N Q the same proportion as C B to C A, and so does the area A N P to the area A N Q.

8. The perpendicular let fall from either S or H upon P T must cut it in a point of the circle A Q M.

9. If C D be parallel to the tangent at P, then C P is parallel to the tangent at D.

10. The parallelogram P C D K is equal to the rectangle of B C and C A, and the sum of the squares on P C and C D is equal to the sum of the squares on A C and C B.

11. The square on P N is *less* than the rectangle contained by A N and N M in the proportion of the square on C B to the square on C A.

12. P G bisects every line parallel to C D which is bounded at both ends by the ellipse, and the square on X Y is to the rectangle contained by G Y and Y P in the proportion of the square C D to that on C P.

13. The square on C D is equal to the rectangle contained by S P and P H.

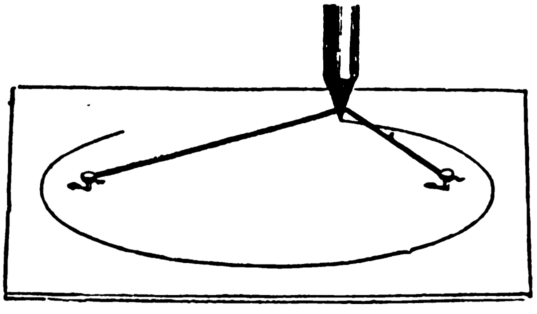
14. The double ordinate parallel to B C through either focus is called the *latus rectum.* The square on P N is always *less* than the rectangle under A N and the latus rectum by the square on a line which is to A N as B C to C A. From this *deficiency* the ellipse derives its name, as does the HYPERBOLA (ὑπερβολή) from a corresponding *excess.*

Such are a few of the countless properties which might be exhibited. But it is to be noticed that the most common and elegant theorems are not those which are found most useful. The striking use of this curve lies in its being the nearest representative of a planetary orbit which can be given in a simple manner. If the planets did not attract each other, but were only attracted by the sun, they would describe absolute ellipses. Their mutual actions being small compared with that which the sun exerts, they consequently move in *ellipses very nearly.* Hence the utility of the ellipse in astronomy; but at the same time the properties of the curve which facilitate the investigation of the heavenly motions present nothing so striking as those which we have given.

The reader who is not versed in geometry must remember that, though an ellipse be an *oval*, yet an oval is not necessarily an ellipse. A figure may be formed by arcs of circles which shall have the appearance of an ellipse without possessing any of its properties.

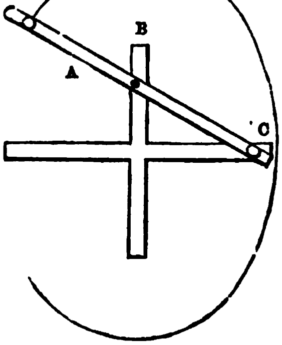
ELLIPSOID. [SURFACES OF THE SECOND DEGREE; SPHEROID.]

ELLIPTIC COMPASSES, the name given to any machine for describing an ellipse. We shall only mention two contrivances of the



kind out of a large number which have been proposed. The first is the simple and rough method suggested by the first property in the article ELLIPSE. Let two pins be fastened to the paper at the points in which the foci are to lie, and let a thread, equal in length to the proposed major axis, have one end tied to each pin. Then if a pencil move in such a way as to keep the thread always stretched, it will describe an ellipse.

The second method is as follows: it is known that if any two fixed points in a straight line A be made to move along two other straight lines, B and C, then every other point in A will describe an ellipse. If then two grooves be made (at right angles to each other, for convenience), and if two pins attached to a ruler be made to travel in the grooves, the motion of the ruler will make any pencil attached to it trace out an ellipse. The distances of the pencil from the two pins will be the semiaxes of the ellipse. If the pins be attached to the ruler by clamping screws their distance may be altered, and the instrument may be made to describe any ellipse within limits depending on the length of the ruler and of the grooves.



ELLIPTIC FUNCTIONS, or ELLIPTIC TRANSCENDANTS. This is no subject for a Cyclopædia, except in a very limited sense. We can only undertake here to describe the general character of the subject.

If we had passed direct from algebra to the differential calculus, without any consideration of logarithmic or trigonometrical quantity [TRANSCENDENTAL], we should have found ourselves stopped in the integral calculus by want of language in which to express the integral of such a function as

$$\frac{dx}{\sqrt{(a+bx+cx^2)}}.$$

It would no doubt have been found (since the same difficulty has been conquered in a more complicated form in the subject of the present article) that all such integrals could be expressed by means of those of

$$\frac{dx}{\sqrt{(a^2-x^2)}} \text{ and } \frac{dx}{\sqrt{(a^2+x^2)}};$$

and the connection of the former of these with the arc of a circle, and of the latter with logarithms, the properties of the functions called sines and cosines, tables of their values, with a complete system of trigonom[illegible]al formulæ, would speedily have followed. From this mode of arriving at a new set of transcendentals we are saved by having the science of trigonometry already prepared on a geometrical basis, in connection with the properties of the circle. But we have no such preparation founded on the ellipse, a curve which is an extension of the circle. Nor is there any connection between the arc of an ellipse and the excentric anomaly, the angle of which is the extended representative of the angle at the centre in the circle, except by means of a definite integral. In fact, a being the semi-axis major, e the excentricity, ϕ the excentric anomaly, and s the arc, we have

$$s=a\int\sqrt{(1-e^2\cos^2\phi)}\,.\,d\phi.$$

The integral calculus is, as yet at least, the only manner in which the arc of an ellipse can be approached: accordingly, a large class of integrals, closely related to, and containing among them, the expression for the arc of an ellipse, have received the name of elliptic functions.

By an elliptic function is meant any integral of the form

$$\int\frac{\text{P}\,dx}{\sqrt{(\alpha+\beta x+\gamma x^2+\delta x^3+\epsilon x^4)}},$$

in which P is a rational function of x. This can be shown to depend for its determination upon the form

$$\int\frac{\text{Q}\,d\phi}{\sqrt{(1-e^2\sin^2\phi)}},$$

in which Q is a rational function of $\sin^2\phi$, and e is less than unity. This, again, can be shown to depend upon

$$\int\frac{\text{A}+\text{B}\sin^2\phi}{1+n\sin^2\phi}\cdot\frac{d\phi}{\sqrt{(1-e^2\sin^2\phi,)}},$$

which in every case depends upon one or more of the three following forms:—

$$\int\frac{d\phi}{\sqrt{(1-e^2\sin^2\phi)}} \quad \int\sqrt{(1-e^2\sin^2\varphi)}\,.\,d\phi$$

$$\int\frac{1}{1+n\sin^2\phi}\cdot\frac{d\phi}{\sqrt{(1-e^2\sin^2\phi)}},$$

which are called functions of the first, second, and third species. Every elliptic function represents the arc of some algebraical curve.

The earliest researches into the integrals connected with the arcs of an ellipse or hyperbola are those of Maclaurin, in his treatise on Fluxions, and of D'Alembert, in the Berlin Memoirs for 1746. Fagnani, in 1750, showed how two arcs of an ellipse might be assigned in an infinite number of ways, which should have for their difference an algebraical expression. Euler, in 1761, showed how to assign the complete integral of certain differential equations of which the terms are separately nothing but elliptic functions. Landen, in 1755, showed that every arc of an hyperbola can be obtained by means of two arcs of an ellipse. Lagrange, in 1785, gave a general method for approximating to the values of elliptic functions of all kinds.

But those to whom it is due that the theory of elliptic functions has become a distinct and important branch of the integral calculus, with general formulæ which have made it an extended form of trigonometry, are Legendre, Abel, and Jacobi. Of these, the first almost devoted his life to the subject. His various memoirs, and his latest extensions of them, are contained in the two following works:—

'Traité des Fonctions elliptiques et des Intégrales Eulériennes,' 4to, Paris, vol. i., 1825; vol. ii., 1826; vol. iii., containing three supplements, 1828; and 'Exercices du Calcul Intégral,' 3 vols. 4to, Paris, 1811. Both these works contain extensive tables for the calculation of the functions.

The memoirs of Abel, the substance of some of which are in the third volume of Legendre, were originally published in Crelle's journal, and are now collected in his works, which were published in French, 'Œuvres de N. H. Abel,' collected by B. Holmboe, Christiania, 2 vols. 4to, 1839. Jacobi's work is 'Fundamenta nova theoriæ functionum ellipticarum, auctore D. C. G. I. Jacobi,' Regiomonti, 1829, 4to. As to elementary works, there is some account of Legendre's first memoirs in the second and third volumes of Leybourn's 'Mathematical Repository:' several works on the integral calculus, that of Mr. Hymers in particular, contain the first elements. There is a work on the subject expressly by M. Verhulst, printed in Belgium; and there is an article on elliptic functions and definite integrals in the 'Encyclopædia Metropolitana.'

Since the publication of the 'Penny Cyclopædia' many researches have been made, which not only illustrate the analogy between elliptic functions and ordinary trigonometry, but advance into higher views of transcendental integration, and foreshadow the time when elliptic functions themselves will be but a particular case of a higher theory. There is an able report on the progress of this branch of analysis up to near 1846, by the late Robert Leslie Ellis, in the Reports of the British Association for 1846. There is also an elementary work, or at least as nearly elementary as its mode of view will permit, by MM. Briot and Bouquet, 'Théorie des Fonctions Doublement périodiques, et, in particulier, des fonctions elliptiques,' Paris, 1859, 8vo.

ELLIPTIC POLARISATION is the name given to a peculiar modification of polarised light, which is thus designated because, according to the undulatory theory, the ethereal particles describe ellipses in the case of light so modified. The term was, however, employed by Sir David Brewster for another reason ('Phil. Trans.,' 1830); and elliptically polarised light is recognisable as such by experimental characters independently of any theory as to its nature.

If ordinary polarised light, which, in contradistinction to light that is elliptically polarised, is called *plane-polarised*, is reflected from the surface of glass or any other transparent medium, the reflected light (neglecting for the moment certain small deviations to be noticed presently) is plane-polarised, having all the characters of light polarised by reflexion from glass at the proper angle, or by transmission through a Nicol's prism, &c. If, however, plane-polarised light be similarly reflected from a metal, the reflected light will no longer be found to be plane-polarised, unless the plane of incidence be parallel or perpendicular to the plane of primitive polarisation, or the angle of incidence be very small or very near 90°. In general, on being examined by an analyser, such as a Nicol's prism, which is made to rotate, the light is never extinguished, but merely passes through a minimum, being a maximum and a minimum alternately at every quarter revolution. So far it resembles partially polarised light, such as common light reflected from glass at an angle differing from the polarising angle, or reflected from a metal. But the two kinds are in reality totally different, as may be seen at once on examining them by a Nicol's prism capped with a plate of calcareous spar, cut perpendicularly to the axis, which is turned towards the light to be examined. Partially polarised light (or, to speak more precisely, partially plane-polarised light), on being examined in this way, shows the well-known rings of a uniaxal crystal, diluted with a uniform light spread over the field; whereas the light obtained by reflecting plane-polarised light from a metal, as above described, shows a system of rings as vivid as those produced by plane-polarised light, but of a different character.

Light is capable of receiving the same modification by total internal reflexion. If plane-polarised light be reflected internally from glass at an angle of incidence exceeding the critical angle (or that at which total reflexion begins), then, unless either the plane of polarisation be parallel or perpendicular to the plane of incidence, or the angle of incidence be very near one of the two limits, the critical angle and 90°, the reflected light will be found to be elliptically polarised, agreeing in its characters with light which, having been previously plane-polarised, has been reflected from metal.

But elliptic polarisation may also be produced without reflexion, in a manner which indicates at once its real nature. If plane-polarised light be transmitted through a thin plate of mica or selenite, then, unless either the principal axes of the plate are parallel and perpendicular to the plane of primitive polarisation, or else the thickness of the plane has one or other of a set of determinate values, the transmitted light will be found to be elliptically polarised, having the same characters as before.

Now, in this case, we know that the primitive plane-polarised light is divided in passing through the crystal into two pencils, which are polarised respectively in the principal planes of the plate, and which after emergence run on together, having been unequally retarded by passing through the plate. It appears, then, that elliptic polarisation, whatever it may be, is capable of being produced by the interference of two plane-polarised beams, of which one is retarded relatively to the other.

If, then, we adopt the undulatory theory of light, and the doctrine of transversal vibrations, we shall be able to form a perfectly clear conception of the nature of elliptically polarised light. According to this doctrine, plane-polarised light consists of vibrations which are rectilinear, and perpendicular to the ray (confining our attention to the case of propagation *in vacuo*, or in a singly refracting medium), and which, like all the phenomena relating to such light, are symmetrical with respect to the plane of polarisation, and are therefore either in or perpendicular to that plane. Opticians are still divided in opinion on the point last mentioned; but for the explanation of the phenomena with which we are at present concerned, it is a matter of perfect indifference whether the vibrations are supposed to be parallel or perpendicular to the plane of polarisation, though, from considerations into which we cannot here enter, the latter view appears the more probable.

Let the ether be referred to the rectangular axes of x, y, z, the axis of x being measured in the direction of propagation, and those of y, z along the principal planes of the plate; and let the plane of primitive polarisation be inclined at angles α, $90°-\alpha$, and to the axes of y, z. Then, if we represent the vibration by $a \sin p\,(vt-x)$, and take y, z to denote the vibrations belonging to light polarised in the planes of $x\,y$ and $x\,z$, the resolved vibrations belonging to light polarised in the principal planes of the plate will be represented by

$$y = a \cos \alpha \sin p\,(vt - x)$$
$$z = a \sin \alpha \sin p\,(vt - x).$$

On emerging from the plate the phase of former vibration will be accelerated or retarded relatively to the latter (suppose accelerated) by δ, and putting ϕ for $p\,(vt-x)+$ a quantity the same for both, we may represent the vibrations in the emergent light by—

$$y = a \cos \alpha \sin (\phi + \delta)$$
$$z = a \sin \alpha \sin \phi.$$

To find the equation to the curve described by the ethereal particles we must eliminate ϕ from these equations, which gives

$$(\sin \alpha . y - \cos \alpha \cos \delta . z)^2 + \cos^2 \alpha \sin^2 \delta . z^2 = a^2 \sin^2 \alpha \cos^2 \alpha \sin^2 \delta,$$

the equation of an ellipse, which, when $\delta = 90°$ or an odd multiple of 90°, and $\alpha = 45°$, becomes the circle

$$y^2 + z^2 = \tfrac{1}{2}\,a^2.$$

Hence the ethereal particles move in general in ellipses, which is the reason why light thus modified is called by undulationists elliptically polarised. It would lead us too far to follow into their details the mathematical characters of the vibrations which, according to the undulatory theory, constitute elliptically polarised light, for which the reader is referred to Airy's 'Tracts,' or other standard works on physical optics.

We are led then to infer that, in the case of light reflected from a metal, or totally reflected internally in glass, the phase of vibration of the component of the reflected light which is polarised in the plane of incidence is changed relatively to that of the component polarised in the perpendicular plane. In the case of metallic reflexion the former component is accelerated, in the case of total internal reflexion retarded, relatively to the latter. This is shown at once by the character of the rings of calcareous spar, observed as above explained, by noticing in which pair of opposite quadrants (whether the first and third or the second and fourth) the action of the spar, as a doubly refracting crystal, compensates the change of phase due to reflexion, the spar being known to be a negative crystal.

From his expressions for the intensity of reflected polarised light, which in the case of total internal reflexion become imaginary, Fresnel deduced mathematical expressions for the change of phase which accompanies total internal reflexion. Guided by these expressions he was led to construct a rhomb of glass (now known as Fresnel's rhomb), a section of which is of the form of a long parallelogram, the acute angles of which are determined by an equation involving the refractive index of the glass, and which for the glass which he employed came out about 54° 37′. Light entering perpendicularly one of the shorter faces emerges perpendicularly at the opposite, after suffering two total internal reflexions at the long faces. The angle of the rhomb is determined by the condition that the difference of phase of the components polarised in and perpendicular to the plane of incidence is one-eighth of an undulation for each reflexion, and therefore one-fourth of an undulation for the two. Such a rhomb is much used in experiments on polarisation; but it is essential that the glass should be thoroughly annealed, a condition for want of which many rhombs made for the purpose are worthless. If plane-polarised light is transmitted through such a rhomb, the plane of reflexion in the rhomb being neither parallel nor perpendicular to the plane of polarisation, the emergent light is elliptically polarised; if through two such rhombs placed with their planes of reflexion parallel, the emergent light, in accordance with the prediction of theory, is found to be plane-polarised, the plane of polarisation being equally inclined with the plane of primitive polarisation to the plane of reflection in the rhombs, but on the opposite side. If, with a single rhomb, the plane of reflexion is placed at 45° to the plane of primitive polarisation, the emergent light is of the kind in which the ellipse of theory becomes a circle, and which is called circularly polarised. Such light is characterised experimentally by presenting the same appearance on analysation when the analyser is turned round, while it differs from common light by presenting a peculiar and perfectly vivid system of rings with calcareous spar, or, if this mode of observation be preferred, by being converted into plane-polarised light by transmission through a crystalline plate of proper thickness, or through a Fresnel's rhomb.

Whether the plane of reflexion in the rhomb be inclined 45° to the right or to the left of the plane of primitive polarisation, we obtain circularly polarised light; but the light so obtained in the two cases differs both theoretically and experimentally in a character of right-handedness or left-handedness. Experimentally the difference is at once recognised by means of a plate of calcareous spar and a Nicol's prism, by noticing whether the rings of the first and third quadrants are pulled out, and those of the second and fourth pushed in, or *vice versâ*. Elliptically polarised light in like manner may be either right-handed or left-handed.

On the subject of metallic reflexion, the reader is referred to Sir David Brewster's well-known paper in the 'Philosophical Transactions' for 1830; and to an elaborate memoir by M. Jamin, in the 'Annales de Chimie,' ser. iii. tom. 19, p. 296. M. Jamin has also ('An. de Ch.' tom. 29, p. 263) investigated, in the case of transparent substances in general, the change of phase about the polarising angle, or, more properly, the angle of maximum polarisation, which Mr. Airy had observed in the case of the diamond. ('Cambridge Philosophical Transactions,' vol. iv. p. 409.)

ELLIPTIC REFLECTOR. If a pencil of light have its focus at one of the foci of an ellipse, rays diverging from such focus striking upon the ellipse, or on any surface with which the ellipse would coincide, would be reflected to the other focus. A mirror formed into the figure of an ellipsoid, or portions thereof, acting on t[illegible] principle is called an *elliptic reflector*. [LIGHT.]

ELLIPTICITY, a term used in the theory of the figure of the earth. It means the fraction which the excess of the axis major over the axis minor of an ellipse is of the axis minor itself. Thus, if the axis major be 9 and the axis minor 7 the ellipticity is $\frac{2}{7}$. This term must not be confounded with the *excentricity*, a word in much more common use. If a and b be the semiaxes major and minor, and if e be the excentricity and E the ellipticity, then

$$\mathrm{E} = \frac{a-b}{b},\ e = \sqrt{1 - \frac{b^2}{a^2}}$$

if b and a be nearly equal, $e^2 = 2\,\mathrm{E}$ nearly.

ELM, *Economical Uses.* The wood and other parts of the elm-tree are applied to a great variety of useful purposes in the arts of life, both domestic and trading. The timber, being hard and fine-grained, is valuable for ship-building, such as in making the blocks and dead-eyes, but especially the keels, which are made in one piece if the keel be not very long. Elm is used for the naves of wheels; in London for coffins; for water-pipes and troughs; and for conveying the Cheshire brine from the salt-springs to the evaporating pans. Knotted and twisted varieties of the wood are much sought by cabinet-makers for ornamental purposes. Elm veneers are sometimes dyed to imitate mahogany, by means of a dye of dragon's blood, alkanet root, aloes, and spirits of wine. As fuel, and as a material for charcoal, the elm is rather inferior to the beech. The ashes are rich in alkali. The leaves and young shoots are used in some parts of the Continent to feed cattle and pigs, and even silkworms. In some parts of Russia the leaves are used as a substitute for tea. The bark is useful as an astringent medicine, and the inner bark for making nets and ropes. The bark and leaves yield an adhesive substance, which may be used as glue. The bark, kiln-dried and ground, and mixed with flour, is used by some of the poor in Norway for bread.

The above details relate to the common elm. The Scotch or wych-elm is equally useful. The timber is much prized by ship-builders, boat-builders, block-makers, pump-makers, cartwrights, cabinet-makers, and coach-makers. For floor-timbers of ships, naves and shafts of vehicles, swingle-trees for heavy gun-carriages, dyers' and printers' rollers, wheelbarrows, and the handles of agricultural implements, the wych-elm is much used, because it cleaves well without splintering. The bark, which is very tough, and strips off easily, is applicable to a great variety of useful purposes.

ELOCUTION. [ORATORY.]

E'LOGE, in the French language means praise, being derived from the Latin *elógium*, and that from the Greek *eulógia* (εὐλογία). It has become the name of a considerable branch of French literature, which comprehends panegyrical orations in honour of distinguished deceased persons. It is the custom when one of the members of the French or other academies dies, and a new member is appointed in his place, for the new member to deliver a panegyrical oration on the labours and other merits of his predecessor. These éloges are generally printed and published, and although they are mostly written in a florid rhetorical style, still many of them are really interesting biographies. Such, for example, are the éloges written by Cuvier and Arago on several of their brother academicians. [CUVIER and ARAGO, in BIOG. DIV.] The custom of writing éloges of deceased persons is not confined to members of academies. Bailly wrote 'Eloges de Charles V., de Molière, de Corneille, de l'Abbé de la Caille, et de Leibnitz,' Berlin, 1770. The Italians have also 'Elogii degli Uomini Illustri Toscani,' 3 vols., fol., Firenze, 1766–70, and many other similar compositions.

ELONGATION, an astronomical term for the angular distance between two heavenly bodies as seen from the earth. Custom has confined it to the case in which both bodies are in the solar system, and one of them is generally the sun. Thus we speak of the *distance* of two fixed stars, and of the *elongation* of Mercury from the sun.

ELOQUENCE. [ORATORY.]

ELUL, אֱלוּל, the last month of the civil year of the Hebrews, coinciding, when earliest, nearly with our August; when latest, with our September. The origin of the name is doubtful: older Hebrew philologers derived it from the word אֱלִיל, "nothing," because nothing remains in the ground at that season! Recent savants more wisely profess their ignorance. Benfey's derivation from the Zend *Haurvat*, through the old Persian month *Chordad*, would seem at first sight absurd, a mere result of dexterous letter-shifting; but if we look at the not unfrequent interchange of *d* and *l* (*Οδυσσευς*, Ulysses; lacryma, *δακρυ*, &c.), particularly in the case of the combination *rd* in old Persian, as in *tharda*, a year, modern *sal*; *warda*, a rose, modern *gul*; we may be induced to suspend our condemnation; more especially when we consider that Chordad was the sixth month in the Persian calendar, as Elul was in that of the Jews until the middle of the 4th century, A.D. It is moreover well known that the names of the months now in use do not occur in any of the books of the Bible written before the captivity, which ultimately brought the Jews under the domination of Persia. Elul is found in the 6th chapter of Nehemiah, 15th verse, where the completion [illegible] the walls of Jerusalem is recorded; it is also found in the apocrypha, in Maccabees xiv., 27.

Two festivals are held in this month; the first is that of the Dedication of the walls of Jerusalem by Nehemiah, on the seventh day of Elul; the other is that of the expulsion of the Greeks, on the seventeenth. Some Jews observe a fast on the seventeenth day, in memory of the death of the spies who brought back an evil report of the Promised Land; Numbers, xiv., 37.

Elul has only twenty-nine days.

ELUTRIATION, the process of separating substances reduced to powder, when of different specific gravities, by means of water. It is also employed as a method of reducing any one substance to a fine powder; thus the creta præparata, or prepared chalk of the 'London Pharmacopœia,' is prepared by mixing finely-powdered chalk with water, stirring the mixture, and while it is yet turbid allowing the upper portion of the water to run off; and when this is allowed to settle, the chalk or any other substance similarly treated settles in a very fine powder. By the process of elutriation ores, especially those of tin, are separated from earthy matter.

ELY'SIUM, the name given by the ancient Greeks and Romans to the abode of the righteous after death. They fancied that there was, somewhere to the west, a region blessed with perpetual spring, clothed with continual verdure, enamelled with flowers, shaded by pleasant groves, and refreshed by never-failing springs, where the souls of the good repaired, and where they enjoyed each other's society. (Virgil, 'Æneid,' vi., with which compare the notion of Elysium in the 'Odyssey,' iv., 563.) The "Islands of the Blest" was another name for this favoured region, which some placed in the midst of the ocean in the farthest west, others in some inaccessible spot in the middle of Asia or Africa. From this notion the appellation of Elysian Fields came to be given to certain delightful secluded spots, such as the strip of land on the northern shore of the Mare Morto, or the inner part of the harbour of Misenum near Naples. It seems to have been originally a vast cemetery, planted with trees and adorned with tombs; but the imagination of the poets confounded the repository of the perishable bodies with the abode of the immortal souls. The Mare Morto was the Acheron through which the dead were wafted to their final abode. Those ancient philosophers who had more spiritual notions of the nature of souls discarded the vulgar idea of the Elysium being in any part of our globe, and placed the abode of the departed in the heavens or firmament. (Cicero, 'Somnium Scipionis.')

EMANCIPATION, Emancipátio. To understand the legal effect of emancipation by the Roman law, it must be premised that all children born in lawful marriage were said to be in the father's power, as well as all his son's children so born before the son was emancipated; and no person who was in the power of another could acquire any property of his own. (Gaius, ii. 86, &c.) Whatever property, then, a son acquired while in his father's power strictly belonged to his father. If the son was by will appointed heir (hæres in the Roman sense), he could not accept without his father's consent, and all that he took was for the benefit of his father: the same rule held as to a legacy. It is unnecessary here to mention the exceptions to the general rule above laid down, or to describe the father's power over the son's person. "There is hardly any nation," observes Gaius (i. 55), "in which fathers have such power over their children as we have." The rigour of the ancient Roman law, however, was gradually relaxed, though the remarks of Gaius, who wrote at least after the time of Antoninus Pius, show that it was not then entirely fallen into disuse. The father's power was dissolved by his natural death, and also by the civil death of the father or the son. (Gaius, i. 128.)

Emancipation was the act by which the power was dissolved or released in the lifetime of the father; and it required the consent of both parties. The emancipation, which was made according to the Laws of the Twelve Tables, was effected by an imaginary sale from the father to another person. In the case of a son, this sale was made three times, as if the father were selling a slave, and the person to whom the sale was made, who of course was some friend, manumitted the son after each sale. After each of the first two sales, the son, being manumitted, became again in his father's power; but the last manumission was final, and extinguished all the father's paternal rights. It was however usual for the son, after the third sale, to be resold to his natural father, who then manumitted him, and thus acquired the rights of a patronus over his emancipated son, which would otherwise have belonged to the purchaser who gave him his final manumission. In the case of a daughter or a grandson, a single sale and manumission was sufficient. (Gaius, i. 132; 'Dig.,' lib. 28, tit. 3, l. 8; 'Cod.,' lib. 8, tit. 49, l. 6; 'Instit.,' lib. i., tit. 12, s. 6.)

The Emancipatio Anastasiana, or that introduced by the Emperor Anastasius, was by Imperial Rescript. ('Cod.,' lib. viii., tit. 49, l. 6.)

The Emancipatio Justiniana was effected by a simple declaration of a father before the proper magistrate, that he released his son from the paternal authority; but the father still retained the rights of a patronus over his emancipated son. (Ibid. l. 6.)

The immediate legal effect of emancipation was, that the person emancipated possessed over his own children the paternal right: he could acquire property, and bequeath it by will. If a son married and had children before he was emancipated, his children were in the power of their grandfather, who could emancipate them without emancipating their father; and such emancipation continued in force after the grandfather's death.

It was also a consequence of emancipation that the emancipated children stood to their father in the relation of strangers, and consequently, in case of intestacy, could not take the parent's property, which could only be claimed by those who corresponded to the legal description of heredes sui, agnati, and gentiles. But this injustice of the civil law (juris iniquitates), observes Gaius, was remedied by the prætor's edict, or, as we should term it, the equity, which was gradually introduced in order to soften the rigour and strict rules of the civil law. [EDICT.] The prætor's edict, however, did not extend to give the same advantage to an emancipated son in succeeding to the property of an intestate brother. The Emperor Anastasius remedied this under certain restrictions; and finally Justinian put emancipated and non-emancipated brothers and sisters and their children on the same footing in all respects as to sharing in the property of a deceased parent or brother or sister. ('Cod.,' lib. vi., tit. 57; 'Instit.,' lib. iii., tit. 5.)

As to emancipation under the Code Napoléon, see liv. i., chap. 3, tit. 10.

EMBALMING. [MUMMY.]

EMBANKMENT, in civil engineering, a mound, or heap of earth, thrown up for the purpose of forming a roadway at a level different from that of the natural surface of the ground; or for the purpose of either regulating the flow of a river or a navigable canal, or of defending low-lying districts from the effects of floods, storms, or high tides in rivers, or upon the shores of lakes or seas. In military engineering, embankments are frequently used to back up the fronts of scarped fortifications, and to form the glacis, the cavaliers, banquettes, caponières, or other earthwork defences; but as the purposes to which embankments are applied in civil engineering are perhaps more important than those connected with military engineering, the former will alone be discussed in the present article.

In designing a roadway, whether for ordinary carriage or railway traction, or in designing a canal, it is desirable, as far as possible, to provide in the work itself for the disposal of the whole of the earth it may be necessary to remove, in order to secure the required conditions of level of the finished surfaces; or, in other words, to make the embankments balance the excavations. This condition very frequently renders it necessary to form very lofty embankments; and the movements these accumulations of earth are likely to produce, or to undergo, render it equally necessary to adopt great precautions in their execution. If, for instance, an embankment should be formed on a compressible or on a shifting subsoil, it may either produce a vertical or a lateral displacement of that surface; or again, if the embankment should have been carried up with undue haste, the loose earth of which it is composed will be exposed to subside, in all probability, in a very unequal manner. Naturally, the precautions to be observed in the various cases thus alluded to, will vary according to the peculiar circumstances affecting them; but the leading principle is the same in all,—namely, that the weight of the material of the embankment must be made to act equally in a vertical direction, and that the tendency to lateral movement should be effectually resisted.

Embankments formed upon peaty subsoils are especially liable to vertical compression; and it is to be observed that, in the majority of alluvial districts, layers of peat are intercalated between the layers of sand, clay, or soft semifluid silt, which constitute the bulk of those deposits. In diluvial, and in many of the clayey series of the older formations, compressible silty beds occur between others of a more resisting character; and if, by reason of the great superincumbent weight, or by any accidental disturbance of the natural conditions of equilibrium of the upper beds, the compressibility of the lower ones should be brought into action, the practical effects produced may become of the most dangerous description. It is, therefore a matter of great importance that borings should be taken all over the area of any intended embankment; and that, if it should be of any great height, the borings should be continued to a considerable depth, especially upon the banks of a river which might be likely to interrupt the continuity of any of the subterranean strata. Very frequently it may also happen that drainage operations may disturb the normal conditions of equilibrium of the intercalated sandy or peaty beds of the alluvial districts referred to above; and in those cases, the subsequent addition of any extraordinary weight, by reason of the execution of an embankment, would require that measures be adopted to limit the range of action of the respective disturbing causes, whether they act above or below the natural surface. Perhaps the best commentary on the principles above stated may be found in a brief description of the practical methods adopted in various countries to ensure the stability of large embankments.

Upon peaty subsoils the whole of the action of the superincumbent weight is frequently resolved into a direct vertical one by means of a double row of sheet piles, which confine the influence of the weight to the precise area so inclosed; or again, as in the case of the embankments executed in Bavaria for the railways carried across the peat bogs of that country, pits are sunk (in the manner of the squares of a chess-board) through the peat, and these pits are subsequently filled in with incompressible materials. In some instances, when heavy buildings (which, of course, act in precisely the same manner as heavy embankments) have been executed upon layers of soft mud of a practically unlimited thickness, they have been laid either upon a wide bed of concrete, or upon a thick bed of fine sand kept from spreading laterally; or they have been founded upon piles driven with their butt ends downwards, as at Brest. The principle observed in all these instances is merely to distribute the weight over a large base; but in Holland, and in many analogous districts, the engineers exercise great skill and ingenuity in the adaptations of means for diminishing the weight of the heart of the embankment,—the portion which precisely would be the heaviest if the bank were executed of solid earth,—by the introduction of layers of reeds, or of fascines. These materials, moreover, tend to distribute the weight over a large area, and they thus produce a double benefit. The sketch given in Minard's 'Traité des Canaux,' &c., of the mode of forming the dykes, or the embankments, across the smaller creeks in the Dutch province of Zeeland, will illustrate the system adopted in the countries above mentioned.

Occasionally the tendency of new embankments to slip laterally is resisted by forming steps in the earth of the subsoil, or by cutting deep trenches at the feet of the respective slopes. It must, however, be evident that the success of these operations must depend upon the nature of the subsoil itself; because, whenever the latter is susceptible of lateral displacement it can serve but little purpose to connect the superincumbent load with it. Stepped seatings, and deep footings have at any rate this advantage, namely, that they resist the passage of water between the natural surface of the ground, and the under surface of the embankment; and therefore, one or the other of them should invariably be resorted to, if there should be any danger from the infiltration of water beneath the seat. Under ordinary circumstances it would be preferable, of course, to form ditches, or drains, for the purpose of intercepting these surface waters; but the additional precautions of stepping, or trenching the feet of the bank, are rarely superfluous. In those cases wherein banks are formed for the purpose of storing large bodies of water, it becomes especially necessary to prevent the passage of the water under the seat of the bank itself; and in all such works (of any considerable magnitude) it is customary to insert what is called a "puddle dyke," or a species of wall of impermeable materials, which is carried through the whole depth of the bank and the porous materials of the subsoil, to the impermeable strata beneath them. Some of the most remarkable works of this description are those lately executed for the catch-water reservoirs of the Liverpool and of the Manchester Water-works, or those executed in America for the Croton Water-works, wherein, by the way, the resistance of the banks to lateral displacement was assisted by the introduction of cribbed or cradle-work, to be noticed hereafter, under WEIR.

Embankments formed upon the sides of running-streams, have to resist not only the tendencies to vertical compression, and to lateral displacement already referred to, and the danger arising from the infiltration of water under their seats, but they have to resist, 1st, the dynamical action of the water at its maximum elevation: and 2nd, the tendency of the current to carry away the materials of which the banks themselves are composed. The former of these conditions will naturally be affected by the height of the water, and, to a great extent also, by its width; for the waves produced in any body of water depend for their height, partially upon the breadth of the surface over which the wind may blow. The latter condition will equally, of course, depend upon the velocity of the current, and the materials which are the most directly exposed to its action must be of such a nature as to obviate any danger of their being displaced by that agent. In the article HYDRODYNAMICS, there will be found a table of the transporting powers of water at different velocities, and the various modes of defending embankments from the action of the waves, or currents, will be discussed under SEA DYKES; RIVER DEFENCES. Of whatever materials such river or sea walls may be externally composed, it is desirable that they should present a very flat slope towards the land side; and that they should be carried up above the highest point to which the waves can reach.

The compression of the materials of an embankment (which is, it must be observed, one of the most important considerations in the execution of such works), must depend mainly upon the mode adopted for the transport and delivery of the materials. Formerly, embankments of small height were executed either by barrow, or cart work, and in regular layers of small thickness; and this mode of execution is still retained in many instances in hydraulic works. But when railways created the necessity for the rapid formation of the colossal embankments, some of which will hereafter be described, it became necessary to introduce a more expeditious, even though less perfect mode of execution. It was for the purpose of meeting this practical requirement of the age that the system of transporting the materials furnished by cuttings to the embankments, by means of railroads and waggons, and of depositing the materials over what is technically called a "flying tip," was introduced. Upon the ancient system, the thickness of the layers of an embankment varied from 18 to 36 inches; whilst upon the modern one, that thickness hardly ever descends below 6 feet, even in forming banks for hydraulic works; and in many instances railway embankments of 30 or 40 feet in height, are made without the intervention of any method for producing a partial compression of the ground. It cannot, therefore, be a matter of surprise that the rate of compression in large embankments should [illegible] between the extreme limits of from $\frac{1}{8}$ to $\frac{1}{12}$ of the finished cubical contents; and it thence becomes necessary both to keep the top of a new bank, formed in the modern style, above the proposed finished height, and to provide for its ultimate compression, by frequent recharges. Especial precautions must be taken against danger from this cause in the case of the embankments required for forming the dams of catch-water reservoirs; and indeed, it would seem to be indispensable that such works should be executed in thin layers, and that each of those layers should be carefully "punned," or rammed; care being taken to prevent the formation of any continuous horizontal bedding in the materials of the bank.

In calculating the respective cubical proportions of the embankments and excavations of a particular work, this fact of the ultimate compressibility of the materials furnished by the latter, and of their primary expansion, must be carefully taken into account. Another practical observation, which perhaps it may be as well to make here, is that embankments formed upon the sloping sides of hills are especially liable to lateral displacement; and that in their construction it is therefore more than usually necessary to step, or trench, the footings or seats, and to provide efficacious means for carrying off the surface or spring waters.

One of the most important details to be considered in forming an embankment is the slope to be given to the sides, for this slope will vary with every description of material employed. Thus, it is found that even in executing the embankments required for supporting ordinary roads or railways (or those which in fact have merely to support a vertical weight), the slope required to be given to loose rubble stone, chalk, loamy sand or gravel, is about 1⅓ base to 1 in height. Light incoherent sand, and ordinary clay, ought to have slopes of about 2 base to 1 in height; whilst the more unctuous clays, such as the Oxford clay or the London clay, frequently require slopes of as much as 3 to 1, in order to prevent slips. Evidently, however, it must be dangerous to lay down any invariable rules on this subject. The nature of all geological materials is liable to great local varieties; and the conditions of the foundations of an embankment, as well as the purposes the embankments themselves are intended to fulfil, differ in such extraordinary manners that it is not possible to say, *à priori*, the course it would be advisable to adopt in every case. It is the duty of the engineer to examine and to allow for the various disturbing circumstances which may affect the application of the general rules above given.

If it should be necessary at any time to form a bridge, or a culvert, drain, &c., under an embankment of any considerable height, precautions must be taken to prevent any unequal thrusts against the side walls of those structures; and the weight thrown upon their crowns must be deposited without producing any sudden shock of a nature to disturb the brickwork or masonry. Care must also be taken to cover the top and the inner sides of the retaining walls with an impermeable material, in order to obviate any danger to the masonry by the infiltration of water through the superincumbent earth. This precaution is far too much neglected in English engineering works, and there can be no doubt but that the fall of many of the railway bridges recently erected may be accounted for by the gradual removal of the mortar from the joints of the masonry, by the passage of the waters falling upon the exposed upper surfaces. It is singular even that there is no special technical word in our language to express the rendering coat laid upon the top of an arch, such as the French word "*chape.*" Hydraulic lime, hydraulic cement, and asphalte, are much used by foreign engineers in the execution of these "*chapes.*"

In addition to the consideration above referred to, with respect to the amount of compression which may be expected to take place in the materials carried to an embankment, according to the method of transport adopted, it is necessary also to bear in mind the relative cost of those different methods, which naturally will vary according to the quantities of earthwork to be dealt with. It is usually admitted that it is preferable to execute embankments, where the rate of compression may be neglected, by means of barrow-work, when the lead, or distance of transport, does not exceed from 70 to 100 yards; when the lead is between 70 and 180 yards it is most economical to employ carts drawn by men, but at about 150 yards lead it begins to be advisable to employ carts drawn by horses; between the distances of 150 and 300 yards, cart-work by horses is decidedly the most economical: but above 300 yards lead there is an economy in using temporary railroads, and waggons drawn by horses, for transporting the material. In very large embankments, locomotives are sometimes advantageously employed, when the lead attains or exceeds a quarter of a mile; local considerations must, however, often render it advisable to modify the application of these calculations.

Amongst the most important embankments hitherto executed may be cited those upon the banks of the Po, the Loire, the Rhine, Meuse, Scheldt, Thames, Ouse, Nene, the shores of Zeeland, Holland, Friesland, &c., to be noticed hereafter; the embankment upon the Ellesmere Canal, near the Pont y Cysilte; the embankments which close the gorges of the gathering grounds of the Liverpool and Manchester Water-works, &c. Upon some of the railways there are also gigantic works of this description; as, for instance, on the Ulm and Augsburg line, the embankment of Gadelbach, cubing 1⅓ millions of cubic yards, nearly; [illegible] of Tabotsofen, on the same line, cubing 1⅓ millions of cubic yards; that of Cowran, on the Carlisle railway, cubing 1⅒ millions of cubic yards; those near Blisworth on the Birmingham railway, of the Pont de Yonne on the Lyon, the Malaunay valley on the Rouen and Havre, the Poincy valley on the Strasburg lines, are of somewhat analagous magnitude.

EMBARGO, the word used to denote the act by which the public authorities of a country lay an arrest on ships to prevent their leaving its ports. On the breaking out of war with any nation it has been usual for the government of each country to lay an embargo upon such of the enemy's ships as are within reach, with a view to their being declared good and lawful prize. During the progress of war, when any expedition is on foot against the enemy, and it is desirable to keep the circumstance from the knowledge of the party to be attacked, it is usual to lay an embargo upon all private vessels, as well those under the national flag as foreign vessels, until the object to be attained by secrecy is accomplished. An embargo may also be laid by the government upon ships belonging to its subjects with a view to their employment for the service and defence of the nation. In all these cases it is clear that embargoes are detrimental to commerce; the only case in which they have an opposite character is when a foreign vessel of war or privateer frequents a neutral port, and is restrained from quitting the same until a certain time shall have elapsed after the departure from the port of any vessel of which it might otherwise make prize.

EMBER-DAYS and WEEKS, certain seasons of the year set apart for imploring the blessing of the Almighty on the produce of the earth by prayer and fasting, observed in the Christian Church as early as the 3rd century. Pope Calixtus, who first directed them to be observed, also ordained that the same seasons should be especially devoted to the preparation of the clergy before their ordination. These seasons are mentioned in the laws both of Alfred and Canute. At first the Ember-days were not uniformly observed by different Churches at the same time; but the Council of Placentia, A.D. 1095, fixed the spring and summer Ember-days to be the Wednesdays, Fridays, and Saturdays after the first Sunday in Lent and Whitsunday; those of autumn and winter upon the same days after the feast of the holy cross (September 14th) and St. Lucia (December 13th). The Sundays immediately following all these seasons are still appointed by the thirty-first canon of the Church of England for the ordination of ministers. The four weeks in which the Ember-days severally occur are called Ember-weeks. Shakspere speaks of Ember-eves. The etymology of Ember-days is uncertain. Some have derived the term from *ember*, ashes; others from ἡμεραι, days; and others from *ymbren*, which in the Anglo-Saxon means a circle or revolution, the Ember-days being set seasons in the course or circuit of the year.

EMBEZZLEMENT, from the old French word *besler*, or *embesler*, to filch, is the fraudulent appropriation by servants and others of money or goods entrusted to their care, or received by them on account of their employers.

By Clerks and Servants.—Is an indictable offence under the 7th and 8th Geo. IV. c. 29, s. 46, and by that statute is declared to be larceny, and punishable with transportation for a term not exceeding fourteen or less than seven years, or by imprisonment for any term not exceeding three years. If the offender be a male he is liable to be once, twice, or thrice publicly or privately whipped (if the court shall so think fit), in addition to such imprisonment. This statute extends to the clerks and servants (both male and female) of all persons, whether in or out of trade, provided they are entrusted to receive moneys for their employers. Notwithstanding the statute declared the offence to be larceny, it was necessary to indict the offenders for the particular offence; and the legal distinctions between larceny and embezzlement being often very subtle, offenders escaped. This was remedied by the stat. 14 & 15 Vict. c. 100, allowing persons indicted for larceny to be convicted of embezzlement, and *vice versâ*.

By Workmen in certain manufactures.—A number of statutes, from the 1 Anne, stat. 2, c. 18, to the 6 & 7 Vict. c. 40, provide against fraudulent appropriations by workmen in woollen, linen, fustian, cotton, iron, and other manufactures, and by colliers and miners.

By Agents, Bankers, Attorneys, &c.—Of moneys and securities, when entrusted to them for any special purpose, is constituted a misdemeanor by the statute 7 & 8 Geo. IV. c. 49, and subjects the offender to transportation, as in the case of clerks and servants, or to fine and imprisonment, in the discretion of the court. Further important provisions for the punishment of frauds committed by trustees, bankers, directors, officers, members of bodies corporate and public companies, and other persons entrusted with property, are contained in the statute 20 & 21 Vict. c. 54.

By Public Servants.—Under the 2nd Wm. IV. c. 4, s. 1, persons employed in the public service and embezzling any moneys or securities entrusted to them are to be deemed guilty of felony, and are punishable in the same manner as clerks and servants for the like offence, except being whipped. Embezzlement of money or stores by officers of her Majesty's forces is provided for by the annual army and marine Mutiny Acts. There are, moreover, several acts relating to the embezzlement of naval and public stores. (See the 55 Geo. III. c. 127, and acts there referred to.) Until the 4 & 5 Vict. c. 56, embezzlement by servants of the Bank of England was a capital felony.

As to bankrupts and insolvents, see BANKRUPT and INSOLVENT.

EMBLEM; in Greek, ἔμβλημα (from ἐν and βάλλειν, to cast in), a thing inserted, inlaid work, mosaic, or the like. [MOSAIC]. In English, an emblem is a figurative representation; a representation which by virtue of association suggests to our minds something not expressed to our senses. For instance, a lion is the emblem of courage, a cock of watchfulness, because watchfulness and courage are qualities commonly associated in our minds with those animals, as their characteristics. So by historical association, without any intrinsic fitness, one thing may become the emblem of another, as the wheel and other instruments of torture are emblems of saints who have perished by them. Any device, however arbitrary, when established by usage as a distinctive mark, may become the emblem and be put for that which assumes it, either in writing or in imitative art; as for instance in Wordsworth's lines:—

> From town to town, from tower to tower,
> The red rose is a gladsome flower, &c.

The red rose is the emblem of the house of Lancaster, though no mention of that house has been made, just as the cross is now the general emblem of Christianity.

EMBLEMENTS, from the French words *emblavence de bled* (corn sprung or put above ground), in its strict signification means the profits of land sown, but in its usual sense it extends to roots planted and other annual artificial profits which arise from the soil, as for example, standing corn, hemp, saffron, flax, hops, and garden produce growing above ground, as melons and cucumbers, all of which annually require either sowing, planting, or manuring at the expense of the tenant, and are not a permanent or natural product of the soil.

By a rule of law founded on public policy, and for the encouragement of husbandry, all persons are entitled to the emblements of land sown by themselves in which they have an uncertain interest, and which is determined either by the act of God, or of the law, between the time of sowing or planting and the severance of the crop.

Thus the representatives of a tenant for life, who dies previous to harvest, are entitled to the growing crops as a compensation for the labour and tillage bestowed on the lands by the deceased. The same rule also exists with regard to a strict tenant at will, if his tenancy is determined by the landlord previously to the corn being reaped, and for this reason, that as the tenant could not know when the landlord would determine his will, he could not therefore make any provision against it, and having sown the land upon a reasonable presumption of taking the produce, the law will not suffer him to be a loser by it. If, on the other hand, a tenant for life or at will puts an end to his occupation by his own act, he will not be entitled to the crops, as no uncertainty can exist on his part, which is the point upon which all cases of emblements rest.

The parochial clergy and their under-tenants, being also tenants for lives, and their representatives, are in like manner entitled to all the advantages of emblements by the 28 Henry VIII., c. 11, sect. 6; and under that statute they are enabled to bequeath by will grain growing upon the glebe land, manured and sown at their own cost; but for the reason above mentioned, a person who resigns his living is not entitled to the emblements.

Fruit trees which cannot be presumed to be planted in contemplation of present profit, but rather of being permanently useful to a succession of tenants, and grass which grows of itself without annual expense and labour on the part of the tenant, are not included within the meaning of emblements. (Woodfall's 'Landlord and Tenant.')

EMBOSSING is the art of producing raised figures or patterns upon wood, metal, paper, cloth, or other materials, by means of pressure; either applied as a sudden blow, as in a stamping-press, or in a more gradual manner, as by an ordinary screw or hydraulic press, or by revolving cylinders. The pattern is usually produced by forcing the face of the material against an engraved die in which the design is cut out or otherwise formed in intaglio. Sometimes, when the article to be embossed is in the form of a thin sheet, a counterpart to the die, often made of lead or other soft metal stamped by the die itself, is applied at the back to aid the process. In many cases heat is employed during the operation with great effect.

The embossing of cloth for book-covers—an important branch of this art—and the process of stamping the covers themselves, are noticed under Bookbinding. A beautiful machine is in operation for both embossing and printing silk, cotton, or woollen cloth, paper, or other fabrics, in one or more colours by one operation, by means of three distinct metal cylinders or rollers, either of which may be employed for embossing or printing, or for performing both operations simultaneously. These cylinders are arranged round, and pressed with adequate force against, a central or bed cylinder of paper, round which the fabric to be embossed is caused to pass. A soft cloth or felt is applied round the surface of the paper cylinder to answer the purpose of what a printer technically styles blanketing; and a smooth iron roller is provided to roll in contact with the paper cylinder, so as to remove any impression which it may receive, through the fabric operated upon and the blanketing, from the embossing roller. In embossing paper, however, this impression upon the bed-roller may be of advantage as a counterpart to the embossing roller; and, in such cases, where it will not produce inconvenience in any other operation of the machine, it may be allowed to remain. Whenever this is done, the relative diameters of the bed-roller and the embossing-roller must be exactly proportioned to each other, in order to ensure perfect register, or coincidence between the sunk pattern on the small metal roller and the raised pattern on the larger bed-roller, during every part of their cycle of revolutions. The embossing and printing rollers are made hollow for the admission of steam or red-hot iron heaters; and they are also furnished with apparatus for applying colour to their engraved surfaces in the same manner as the cylinders of an ordinary calico-printing machine. For embossing velvets, plain cloths, and papers, the surface of the embossing roller must be cut so as to leave the pattern or device elevated: such pattern being, consequently, impressed into, not raised upon, the surface of the fabric; while for woollens the device must be excavated, or executed in recess or intaglio. The patterns produced by the former kind of roller, though commonly called embossing, do not strictly accord with the definition above given, which conveys what appears to be the strict sense of the word.

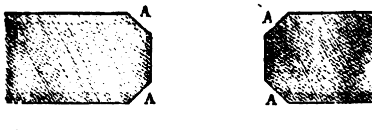
A very curious process of embossing wood was devised some years ago by Mr. Straker. Raised figures on wood, such as are employed in picture frames and other articles of ornamental work, are usually produced either by means of carving, which is an expensive operation, or by applying to the plain surface of the wood ornaments cast or moulded in plaster of Paris or some similar composition—a plan which is not always available. Mr. Straker's invention was intended to facilitate these operations. If a depression be made upon the surface of wood by a blunt instrument which will compress its substance without actually taking away any portion of it, such depressed part will again rise to its original level if the wood be subsequently immersed in water. He therefore proposed to draw the required pattern upon the surface of a piece of wood previously cut to the required shape, and then to apply a blunt steel tool, burnisher, or die to all those parts of the pattern which are intended to be in relief, so as to form depressions in the surface of a depth equal to their required prominence. In doing this, care must be taken, by the very cautious driving of the instruments, to avoid breaking the grain of the wood. The whole is then to be planed or filed down to a uniform surface, after which the wood is steeped in hot or cold water; by the action of this water the parts previously depressed will rise to their former height, and consequently form an embossed pattern which may be finished by the ordinary operations of the carver. A more recent process, to which the name of *Xyloplastics* is given, consists in pressing soft wood into iron moulds, from which it receives a permanent and sharp impression in bas-relief; the wood is softened by steam, and is imbued with certain ingredients to give it ductility.

Very beautiful ornaments of embossed leather, available in lieu of carving for architectural decoration, medallions, picture-frames, cabinet-work, and similar purposes, are produced by a process patented by M. Claude Schroth. The dies are made of type-metal, or of the fusible alloy with bismuth, called D'Arcet's. The leather is beaten soft in water, then wrung, pressed, rolled, and fulled as it were, by working it with the hands till it becomes thicker and quite supple. In this state it is laid on the mould, and forced into all the cavities by means of a wooden, bone, or copper tool. In other cases the embossing is performed by the force of a press. The leather, when it has become dry, is easily taken off the mould, however deeply it may be inserted into its crevices, by virtue of its elasticity. The elasticity which thus enables the leather to be removed from an undercut mould is also important as a means of preserving the ornaments from injury by fracture. Remarkable delicacy and sharpness characterise the ornaments thus formed, which may be produced at a moderate expense; while, from the nature of the material, they are little liable to injury. See further on this subject under Leather.

A beautiful process of embossing has been invented by Mr. Edwin Hill, for the production of the coloured medallions impressed on some of the many varieties of envelopes. The colouring and the stamping are both effected by the same machine. The envelope, whether made by hand or machine, is placed upon a small iron table or bed, adjusted to the right position by guide pieces. The stamp or die is at the same time receiving a coating of ink; which, applied only to the *raised* parts of the die, will affect only the *sunk* part of the impression. The die descends, makes the impression, and rises again. One attendant is constantly employed in placing the envelopes for stamping, and another in removing them when stamped. These movements take place sixty times in a minute. The die coats itself with ink or colour by means of composition rollers and an inking-table, somewhat in the same way as a printing-machine. The same machine, or one similar in principle, is applicable to the embossing of paper wafer-medallions. The envelope-embossing apparatus is nationally very important, for each stamped envelope becomes at once a species of paper-money, exchangeable at many times the actual cost of manufacture. The embossing is on this account conducted at Somerset House, by government officers.

EMBRACERY, an attempt to influence or corrupt a jury, or induce them to favour one of the parties in a cause. It is punished by fine and imprisonment. The crime of embracery is completed whether the jury on whom the attempt is made give any verdict or not, or whether the verdict given be true or false.

EMBRASURE (in Architecture) is the indent of a battlement. [Battlement.] It is sometimes used, also, for the splay of a door or window. In walls of some thickness the apertures are splayed on the inside or outside, or both, in order to admit more light, thus making the angles of the wall obtuse instead of rectangular: thus—



A A are splays forming the embrasure. The term is derived from the French.

EMBRASURE (in Fortification) is the opening made in the epaulment or parapet of a battery or fortress, to allow a gun to be fired through it. The part of the interior slope of the parapet immediately below the embrasure is termed the *genouillère*, and its height is of course determined by the height of the carriage of the gun; for field-guns it is therefore 3 feet 6 inches, and also for siege-guns on travelling carriages, while for guns on standing carriages it is only 2 feet 4 inches. The embrasures may be either cut out of a parapet after it is made, or the openings left when the parapet is being constructed; in either case the height of the *sill* or *sole* of the embrasure should not be much more than 4 feet below the crest of the parapet, otherwise the cheeks or sides of the embrasure, being very high, the concussion of the air from the explosion of the gun is sure to cause them to fall in. If therefore, the parapet be more than 8 feet high, it is better to raise the terreplein of the gun. In laying out an embrasure, the usual rule—namely, that given by Sir Charles Pasley—has been to make the neck or interior of the opening 2 feet wide for guns and 2 feet 6 inches for howitzers; and the embrasure being funnel-shaped, with its greatest opening to the front, the inclination of the cheeks to one another is determined by making them widen out 6 inches at the distance of 5 feet; that is, the centre line, or line of fire, being laid down, the bottom of each cheek is made 1 foot from this line at the neck and 1 foot 6 inches from it at 5 feet to the front. This opening of 2 feet for the neck of the embrasure was found too small for the heavy guns and continuous firing used at the siege of Sebastopol, where they were increased as follows: for

Heavy 32-pounders	to 2 feet 6 inches
8-inch guns	„ 2 „ 9 „
10-inch guns	„ 3 „ 0 „
Lancaster guns and 68-pounders .	„ 3 „ 8 „

They should, however, be as small as possible, to afford protection to the gunners.

The cheeks of the embrasure are made almost perpendicular at the neck where the effects of the explosion are slight, and gradually sloping outwards to the front, in order that they may be the better able to withstand this effect: they are, in fact, what is termed in mechanics "in winding,"—that is, not in the same plane. They are revetted according to circumstances with timber and planking, fascines, or gabions,—the former being perhaps the best and the latter the worst description of revetment, though from its being the most accessible the most ordinarily used. Four or five gabions are placed in each cheek; though at Sebastopol eight and nine gabions were required in a parapet 24 feet thick at top (a great thickness, necessitated by the heavy guns, 56- and 68-pounders, of the besieged), in consequence of the looseness of the soil, which, where not retained by some revetment, soon fell in and choked the embrasure. The gabions were again covered with raw hides, hurdles, &c., to protect them from the effect of rapid fire. The Russians in many instances used the large iron ships' tanks taken from the dockyard to revett their embrasures. Embrasures are occasionally revetted with sand-bags, which, unless protected by raw hides, are soon burnt by the flame from the muzzle of the gun. Sandbags are, however, very useful to stuff the gabion revetement of an embrasure with, instead of filling them with earth, which is liable to be shaken out by firing. The sole of the embrasure is, for direct firing, made sloping slightly downwards to the front; but for ricochet firing, where the guns are always fired at a considerable angle of elevation, they are made countersloping.

EMBROCATION (from ἐμβροχή), a moistening, a term employed to denote external applications, which had for their object to soften and dissipate swellings: in this sense they do not differ from fomentations; but the word has been extended beyond its original meaning, and signifies oleaginous or spirituous compounds, which may excite the vessels of the skin to increased action, and produce all the effects of counter-irritants, or by their influence on the extremities of the nerves may assist in resolving spasm, and so act as antispasmodics.

EMBROIDERING AND SEWING-MACHINES. The word embroidery, as employed in the writings of the ancient historians, has reference to all kinds of ornamental work done with the needle; thus comprehending within its meaning every description of decorative needlework, including tapestry and some descriptions of weaving. At the present day, however, the application of the term is much more limited, relating to one kind of needlework only, which, nevertheless, embrac[illegible]eat variety, both as to the materials employed and the mode of using them. The recent invention and amazing extension of *sewing-machines* give a new scope to the term; seeing that the embroidering machines and sewing-machines are so nearly alike in principle, that they had better be described together. It will be convenient, therefore, to treat the subject here under the sub-headings,—Hand-embroidery, Embroidering Machines, and Sewing Machines.

Hand-embroidery.—Some of the modes of hand-embroidery partake of the nature of TAPESTRY; but there is one method, in which a very rich effect is produced by inserting pieces of cotton wool, or slips of parchment cut to suit the devices, between the fabric upon which the embroidery is executed and the threads of silk or other material of which the pattern is formed, so that the embroidery may be raised considerably above the surface. Gold and silver thread are often used in embroidery with good effect, and spangles or tinsel are occasionally mixed with the needle-work. The fabric to be embroidered is usually stretched in a kind of frame or loom, and the pattern is drawn either upon its surface, or, if it be very transparent, upon a piece of paper applied underneath it.

The Orientals have always paid more attention to this art than Europeans. The Hebrews had elaborate embroideries in their tabernacle and on their priests' vestments. The Egyptians embroidered their linen garments, and the linen-wrappers of their mummies. The Greeks, the Sidonians, and the Phrygians, were all skilled in this art. The Peruvians, too, when discovered by the Spaniards, astonished them by their elaborate embroideries of gold and silver on feathers. In the embroidery of the middle ages, priests' vestments, hangings, veils, canopies, curtains, door-screens, and corridor-linings, were all operated upon by the needle; noble ladies and their hand-maidens produced the specimens for domestic use; while nuns produced the chief portions for ecclesiastical and sacerdotal adornment. There were three modes practised in those days:—the *low* embroidery, in which the threads were laid flat on the groundwork; the *raised*, in which the figures were in relief, and rounded by means of wool, cotton, parchment, or paper placed beneath the thread; and *gimped*, in which the figures were formed by cords of gold, silver, or silk, and pieces of velvet, satin, silk, or gold. The finest modern examples of hand-embroidery are those produced by the Chinese, Turks, Hindoos, and Persians; some of these workers will put as many as 700 stitches in a square inch.

Embroidery, as a handicraft employment, is in our day singularly affected by changes of fashion. About the year 1846, embroidered dress-pieces for ladies came into vogue; and in a short time there was employment for 2000 hand-embroiderers in London alone, and many thousands in Scotland and Ireland. A pattern was printed in outline on the merino or other material; the stuff was then distributed by travelling agents; and after the embroiderers had worked it, the agents re-collected it. Such dresses are now (1859) nearly out of fashion, and embroidery (as a regular branch of trade) is chiefly applied to window-curtains, table-covers, valences, borderings, and other furniture fabrics. The sewed-muslin work, sent out by Glasgow manufacturers to the Scotch and Irish peasantry, has sent to those countries a certain facility in doing embroidery work whenever the fashion tends in that directio

At the Paris Exhibition, in 1855, several machines were shown, much used in France for pricking or piercing the lines of embroidery, to enable the embroiderers to transfer these lines to the cloth by rubbing coloured powder through the holes. This pricking, which is a very tedious process when performed by hand, is effected by the machines with great rapidity and precision. A jointed frame carries a needle, which vibrates vertically by means of a treadle and connecting cords passing over pulleys. The pointer or pricker, when guided over the traced lines of the design, will make as many as seventy or eighty holes in an inch.

Mr. Hope, in 1855, patented a method of producing effects somewhat resembling what is called *appliqué* work: not by actual embroidery, but by printing patterns on the textile material, either by block-printing alone, or by block-printing combined with embossing. The pattern produced is subsequently finished at pleasure by the needle. Any tint or shade of colour may be used, different from that of the textile material. Surface-printing will suit in some instances, but block-printing is better, seeing that it causes the colouring material to enter more durably into the fibres.

What is now called *Berlin Work,* though not exactly embroidery, may be briefly touched on here. Miss Lambert, in her 'Handbook of Needlework,' gives some interesting details concerning its origin. The kind of work itself is, of course, old enough; the only novelty consists in the care bestowed on the production of patterns. About the year 1805, a Mr. Phillipson published some patterns, which, being badly executed and devoid of taste, did not meet with encouragement. In 1810, Madame Wittich, a lady of great taste and an accomplished needlewoman, justly appreciating the advantages which the art would derive from the production of better patterns, prevailed upon her husband, a print-seller of note at Berlin, to undertake the publication of a series of designs. He did so; and the designs were got up in so superior a manner, that many of the first patterns which were issued from his establishment have had a continued demand almost to the present time. The designer and engraver of these designs are paid as *artists,* in proportion to their talents. The cost of the first coloured design on point paper (divided into small squares) varies from three to thirty or forty guineas; but in some instances, such as the large patterns of Bolton Abbey, Boccaccio's Garden, &c., it is considerably more. The colouring affords employment for men, women, and children. A dozen or so of copies are given to each person at a time, with the original design as a guide. The earnings are from sixpence to three shillings a day, according to the age and skill of the persons employed. Berlin workers have had their work facilitated by an ingenious frame, registered by Mr. Lisle. From a flat horizontal stand rise two pillars, which support the frame somewhat in the same way as a toilet looking-glass is supported, so that the frame may be placed and secured in any convenient position. The canvas or other woven material is wound on rollers, which turn easily on their axes; all the canvas is wound on one roller in the first instance, and is unwound to the other roller as fast as the work proceeds; the space between the two rollers being occupied by a smooth well-stretched portion of the canvas. The rollers are worked by small handles, and there are crotchet-wheels to prevent them from slipping backwards. The side or selvage edges of the canvas are kept stretched by two rods. By this apparatus the Berlin worker or embroidress can work on a piece of canvas of almost any length.

In reference to the designs for patterns in hand embroidery, Mr. Wallis, in a paper drawn up in 1856, said: "In embroidery, the ultra-naturalesque forms which prevailed some six or seven years ago are giving way to a class of designs more suited to production by the needle. Much of this is doubtless to be attributed to the severe character of the ecclesiastical embroidery, for which there has more recently been so large a demand."

Embroidering Machines.—Although embroidery has, until within a few years, been a purely handicraft employment, chiefly cultivated by females as a tasteful and elegant occupation or amusement, it has also assumed the character of a manufacture, a most ingenious machine for executing it having been invented by M. Heilmann, of Mühlhausen. This admirable contrivance, which enables a female to embroider any design with 80 or 140 needles as accurately and expeditiously as she formerly could with one, requires the labour of one grown person to superintend the work, and of two children to change the needles when their threads are used, and to watch continually for any irregularities of action which may need attention. The chief parts of the machine may briefly be described as follows: The needles, which are pointed at both ends, and have their eyes in the middle, so that they need not be turned round between each time of passing through the web, are passed backwards and forwards by the action of small pincers, of which there are two pair to each needle, one on each side of the web, each pair being alternately employed in pushing and pulling the needle through the web. As soon as the needles have passed completely through in either direction, a kind of carriage or framing, which carries the series of pincers by which they have been drawn through, begins to move along a railway so as to draw the needles to the full length of their threads; after which the carriage returns to its original position, and its pincers put the needles again through the web, to be received on the opposite side by the other set of pincers, which then retire with them in like manner. So far as the action of this part of the machine can affect the matter, the needles would continually pass through the same holes in the web; but to enable them to pass through it at different points in succession, according to the pattern required, the web itself, which is placed vertically in a frame furnished with rollers on which it can be wrapped as on the roller of a loom, is caused to assume a different position after each passage of the needles. This is done by connecting the frame with a kind of pantograph, the point or tracer of which can be moved at pleasure over every portion of a drawing or pattern, which represents, on a greatly enlarged scale, the flower or device to be embroidered. The operator brings the point of the pantograph successively to every point of the pattern device at which it is desired to plant a stitch; and by this means so moves the web-frame that the corresponding point of every flower, or place where a flower is to be worked, upon it, is brought opposite to the point of one of the needles. The mechanism by which the pincers are worked is then brought into action by means of handles and pedals, by which every needle of the series is put through the web, and drawn until its thread is brought home; after which the needles return to their original position, while by the working of the pantograph another point, or rather series of points, of the web is brought opposite to them ready for the return stitch. By such means every needle of the series produces a distinct and separate copy, on a small scale, of the pattern, the arrangement of the stitches being precisely according to the movements of the pantograph.

This very ingenious machine was sold by M. Heilmann to Messrs. Köchlin, of Muhlhausen, who patented it in England. All the English rights were afterwards purchased by Mr. H. Houldsworth, the eminent silk-manufacturer of Manchester; he greatly improved the machine, and made an arrangement with Messrs. Schwabe for the joint use of the patent. In its present and most improved form, the machine consists essentially of four parts—an embroidering frame, on which the cloth to be embroidered is stretched; a pantograph attached to the frame; a series of needles and pincers; and mechanism for passing and re-passing the thread through the fabric. The cloth is stretched vertically. The design is sketched on stout paper or on tin-plate, usually six times the size of the work to be done. The pantograph conveys the design, as it were, from the drawing to the cloth. The length of all the stitches is arranged to a definite scale; a hole is punched in the paper at each end of every stitch; the pointer of the pantograph is moved backwards and forwards over the system of holes, thrusting into each hole in turn; and with each movement the needles are drawn backwards and forwards though the cloth. The action of the needles, although improved like everything else belonging to the machine, may be understood from the description given in the last paragraph. Some of the machines are large enough to employ six persons; some are small enough to be worked by one. Very little hand-work is necessary in finishing embroidery worked by these machines. There are certain limits, beyond which, machine-embroidery is not so useful as that effected by hand; but it has this merit, that the embroidering is equally good on both sides of the cloth. Mr. Houldsworth has invented a mode of embroidering in curves; he stretches the fabric on elastic cross-pieces; screws it up so as to draw the threads into a curved line; embroiders in a *straight* line; loosens the screws; and allows the cloth to resume its original position—the rows of embroidery stitches then appear in curved lines instead of straight. In producing a chintz-like effect, many colours are used in many needles. Another mode of producing variegated effects is to dye the silk thread differently at different parts of its length.

Attention has been drawn by Mr. Wallis to two circumstances affecting in an important degree the use of embroidering machines; namely, their limited scope for elaborate work; and their influence on artistic design. On the first point he says: "In variety of effect the embroidering machine can never compete with hand-embroidery; and although, as in the dress embroidered for her Majesty by the late Mr. Louis Schwabe of Manchester, the effects of the original drawing are given in all their variety, this has only been effected at a great sacrifice of all the economical powers of the machine. When Mr. Schwabe first showed me this specimen in 1844, he said, 'I am written to, and asked if my machine would execute the design? I replied, that any design which her Majesty wished executed should be produced by it. When the drawing came, I saw the mistake I had made; but resolved, cost what it might, that the work should be done—and there it is.' As an illustration of what can be done by the embroidering machine, the example is interesting; but as an illustration of its economical use, or its superiority over hand-embroidery, it is worthless." On the other point, Mr. Wallis remarks: "Silk at 40*s.* a pound is too costly to be wasted; therefore, it is desirable that each needleful should do its work, and that no fragments should remain to be cut away at a loss. Hence patterns have to be designed to the needleful. If a pattern, however excellent in the abstract it may be, consumed one needleful of 36 inches out of two needlefuls of 42 inches each, it would be considered anything but sound economy in machine-embroidering to execute it, as 8 (6?) inches would be lost for each needle employed—a waste, upon any extent of production, which would astonish those who are not in the habit of thinking about mere fragments in the materials of manufacture. It will at once be seen from this fact, that the design for machine-embroidery must ever be somewhat peculiar, and to a certain extent limited in range of form; and that all the most successful—certainly the most economical—are made almost in the presence of the machine by which they are to be executed, and for the most part under no higher inspiration than that of a species of artistic measure-table: such as 'two needlefuls make one flower; three flowers make one repeat; twenty repeats make one border; four borders make one table-cover decoration.' One can thus tell, almost to an inch, certainly to a yard, how much silk will be consumed in a given operation."

Sewing Machines.—We must now pay attention to those machines which perform the operations of sewing and stitching, instead of that of embroidery.

It is evident, on a slight consideration, that the principle of these machines is nearly identical, however dissimilar may appear the mode of working. In both, there are needles threaded with cotton, silk, or other material; and in both, the needles pass to and fro, from one surface to the other of the piece of cloth, leaving tightened convolutions of thread to mark their passage. The two chief points of difference are, that the needles are more fixed in position in the sewing than in the embroidering machines; and that the object in view is rather to fasten and strengthen than to decorate. To describe the numerous patented sewing-machines in detail would be both tedious and unnecessary; a few words relating to Newton and Wilson's Boudoir Sewing-Machine will suffice, as giving one particular type of a large class. This machine is constructed chiefly for domestic sewing, and for light manufactures. It is mounted on a portable table; under the table is a treadle acting on a small friction-wheel, which drives two small levers, one above and one below the bottom of the machine. The upper lever carries a *piercing needle*, and at the same time feeds the machine with its work, carries it forward, and regulates the length of the stitches. The under lever carries a *looping needle*, for completing and securing the stitch on the under side of the cloth. This looping needle, or looper, is a hook, which takes hold of the loop of thread after it has been passed through by the piercing needle, and retains it till this last-named needle, passing again through *the cloth*, enters this loop and leaves another, drawing the first loop tight in its receding motion. The stitch thus made is what embroiderers call the *tambour-stitch*. Instead of this a different stitch is formed, by using a looper which has a hook with a longer point, with an eye formed to carry a second thread; the needle and this looper, by alternately intercepting the threads they respectively carry, form an interlaced or *chain-stitch* on the under side of the piece of cloth; while both together form a *back-stitch* on the upper surface. This machine can turn down, fold, hem, and lay on and fix binding, as well as perform sewing and stitching.

A few figures were given in the 'Mechanics' Magazine,' about the middle of the year 1859, showing to how astonishing a degree the use of sewing-machines has extended. The following appeared as the result of inquiries made in England, and in the United States:—

	Great Britain.	United States.
No. of patents granted . . .	200	300
Manufacturers	5	25
Kinds of sewing-machines . . .	6	30
Kinds of lock-stitch machines . .	3	10
Machines sold weekly . . .	100	1500
Prices	3*l.* to 30*l.*	1*l.* to 30*l.*
Lowest prices for lock-stitch machine	11*l.*	10*l.*
Whole No. in all	10,000	100,000

Some of the English patents (dated before 1852) do not extend to Scotland or Ireland, and American sewing-machines are largely employed in those two portions of the United Kingdom; but in England and Wales the American machines are virtually shut out.

In both England and America the use of the machine is largely extending. The shirts, collars, and mens' clothing sold in the London shops, are in considerable part either stitched or sewn by machines. Army clothing is begining to be sewn in the same manner, especially in Ireland, where the cheaper American machines may be employed. Mr. Peter Tait, of Limerick, in evidence given before the Contracts' Committee of 1858, stated that he cuts out army clothing by steam-power, and effects much of the sewing by machines worked also by steam-power; he can make 4000 suits of Infantry clothing per week, if needed; and employs several hundred men in the finishing operations, none at less than a guinea a week. In America, Cincinnati is the great clothing town for the Western and Central States. The articles are cut out in large warehouses, then given out by contract to master-tailors, who employ hands by the day or by the piece; sewing-machines are very largely employed in the making up, each doing as much work as ten hand sewers. In 1851, there were 108 establishments employing 10,000 hands; and in the next eight years there was a large increase. The owners of most of the establishments are German Jews, and the workmen Germans.

EMERSION (Astronomy), the reappearance of one heavenly body from behind another after an eclipse or occultation.

EMERY; EMERY PAPER. In the NATURAL HISTORY DIVISION, under ADAMANTINE SPAR and CORUNDUM, a brief notice is given of the mineralogical structure and constituents of emery. We shall here add a few details concerning the manufacture and trade, of recent date.

Dr. Lawrence Smith, an American geologist, made the discovery of a deposit of emery while residing at Smyrna in 1847. On reporting his discovery to the Turkish government, a commission of inquiry was instituted, and the subject soon acquired mercantile importance. Arrangements were made with a mercantile house at Smyrna, leading to an increased sale and a diminished price of Turkey emery. The mining of the emery is of the simplest character in the vicinity of Smyrna. It is rarely necessary to explore the rock in which the lumps of this mineral are found; for a certain redness of colour in the earth immediately surrounding each lump nearly always indicates the exact locality of the emery. Sometimes, before beginning to excavate, the spots are sounded by means of an iron rod with a steel point, and when any resistance is met with the rod is rubbed in contact with the resisting body: the effect produced on the rod enables a practised eye to decide whether it indicates emery or not. The smaller blocks are carried away first in the state as obtained. The larger blocks are broken by hammers; or, if this does not suffice, they are subjected to the action of fire for several hours, and on cooling they easily yield to blows. It occasionally happens that large masses are abandoned from the impossibility of breaking them into pieces of convenient size, seeing that the mode of transportation, either on camels or horses, requires that pieces shall not exceed 100 lbs. in weight each.

When the blocks of emery have been conveyed to the manufactory, they are broken up by hammers into pieces nearly similar in size to the stones for macadamising roads. These pieces are then reduced to coarse powder, either by rollers or by stampers, driven by water or steam power. The coarse powder is next sifted through cylindrical wire-cloth sieves, the cloth having from 16 to 90 wires to an inch-degree of fineness in the wire-cloth gives name to the different qualities of emery produced. No. 16 sieve gives emery about the size of mustard-seed; engineers sometimes require fragments nearly as coarse as pepper-corns; the kind numbered 90 is very fine; and some for special purposes, as high as 120, is sifted through lawn-sieves. The finest obtainable is that which floats in the atmosphere of the stamping-room, and is deposited on the beams and shelves, from which it is occasionally collected. When reduced to a powder, emery varies in shade from dark gray to black; but the colour affords little or no indication of its commercial value. The chemical and mineralogical constituents are noticed in the NATURAL HISTORY DIVISION, and need not engage attention here.

The manufacturers who prepare emery for the market seldom wash it; this is done by the purchasers, glass-makers and others, who require a greater degree of precision than can be obtained by sifting. The manufacturers of plate-glass, who require large quantities, sometimes adopt the following plan: Twelve or more copper cylinders are prepared all alike about 2 feet in height, but of different diameters, the smallest 3 inches and the largest 40. They are placed on a level, in a row; there are small troughs or channels of communication at their upper edges, and the largest has a waste-pipe near the top. In beginning the process, all the vessels are filled with clean water. The pulverised emery, churned up with abundance of water in another vessel, is allowed to run into the smallest cylinder through a tube opposite the trough leading to the second cylinder. During this short passage the water deposits such of its coarsest emery as will not bear suspension even for that limited time; flowing onward, it deposits particles a little finer in the next cylinder; and so on throughout the whole series. Eventually the water forms a very languid eddy in the largest cylinder, and deposits therein all the remaining particles. If there are twelve cylinders, emery powder of twelve different degrees of fineness is then obtained. The powder, when the water has been drained off, is carefully dried for use.

Emery is employed in various ways in manufactures. *Emery powder* is applied to the grinding of glass and the polishing of metals and numerous other substances, sometimes dry, and at other times moistened with oil or with water. *Emery paper* consists of a thin layer of the powder cemented to a sheet of paper by means of glue. There are six or seven degrees of fineness, depending on the meshes of the sieve employed in sifting. Emery paper is either used by the hand, or it is wrapped round a slip of wood to act like a file; if moistened with oil, it cuts more smoothly, but leaves the surface more dull. *Emery cloth* differs from emery paper only in the use of thin cotton cloth instead of paper as a foundation for the powder; it is less useful to engineers and other artisans, as being too flexible, but it is preferable for many household purposes. *Emery sticks* are carefully formed slips of wood with a layer of the powder glued on their surface; the sticks are from 8 to 12 inches long, and may vary in section as much as files. For engineering processes, or metal work generally, they constitute a mode of employing the powder more economical than emery paper. *Emery cake* consists of a mixture of bees'-wax with emery powder, carefully made by heating, stirring, kneading, and rolling. It is employed for dressing the edges of polishing-wheels in cutlery and other manufactures. It is sometimes applied to the wheel while revolving, but more usually when stationary. *Strop paper* consists of a peculiar mixture of emery, glass, and paper pulp, made into sheets, and pasted or glued to the surface of a flat piece of wood, to be employed as a razor-strop when slightly rubbed with oil: the emery and glass together constitute more than half the weight of the prepared paper. *Emery wheels* are made of a composition of coarse emery powder with pulverised Stourbridge clay, moistened to a thin paste with water, and pressed into shape by means of a metallic mould. After being dried and baked it forms a sort of artificial emery stone, which cuts very quickly and yet wears away slowly. It is employed in the form of wheels, discs, or laps, suitable for grinding, cutting, and polishing glass, enamels, metals, and other hard substances. *Emery stone* is sometimes made of flour-emery alone, forced into and shaped by a metal mould, without the addition of any clay, and then baked. It will produce a very smooth surface, but not a high polish. *Waterproof emery cloth* or *paper* is prepared by coating the material on both surfaces with a mixture of boiled linseed oil, African copal, Venice turpentine, Venetian red, Prussian blue, and litharge, and then sifting pounded emery on one or both of the moistened surfaces.

EME'TICS (ἐμετικὰ) are substances which influence the stomach in a peculiar manner, so as to invert its action and cause vomiting; and this effect is produced without reference to the quantity of matter introduced into that organ or into the circulation. This definition is intended to exclude, on the one hand, the mere inversion of the stomach by the introduction of food or drink, either in inordinate quantity, or of too stimulating a quality; and, on the other, to comprise those means of causing vomiting by their direct introduction into the circulation by injection into a vein. The action of emetics must be viewed in two stages, the primary and secondary. The primary effects of emetics are limited to the emptying of the stomach, compressing, during the act of vomiting, the gall-bladder and pancreas, and exciting to contraction the muscular parieties of the abdomen and thorax, as the machinery by which the process of vomiting is chiefly accomplished. We shall here briefly trace the obvious phenomena of this process, without attempting to account for their occurrence.

Soon after a quantity of an emetic substance or solution (such as ipecacuanha or emetic tartar) has been received into the stomach, a feeling of anxiety is experienced in the epigastrum, a general uneasiness termed nausea is felt, which progressively becomes greater, till it ends in the forcible expulsion of the contents of the stomach. This gives a succussion to the whole frame, every part of which experiences more or less of a vibratory motion. The condition of the system is considerably different prior to and during the act of vomiting. In the preliminary stage, the countenance is pale and collapsed; the pulse is small, contracted, irregular, but quick more generally than slow; chilliness is felt, and a cold perspiration may ooze from the surface, all which symptoms disappear when the expulsive movement takes place. Then the face appears flushed; the pulse becomes quicker, fuller, and stronger, and rarely subsides till some time after all vomiting has ceased. If, after a brief interval, the expulsive action be not renewed, a state of langour succeeds, with tendency to sleep, and generally a considerable flow of warm perspiration.

Such are the effects of an emetic, when given in a dose sufficient to produce vomiting; but, if given in a smaller quantity, and repeated at intervals, it will merely create a state of nausea, during which the appetite is lowered, and arterial action is much diminished, while the function of absorption is roused to great activity.

The secondary effects of emetics depend upon the succussion of the frame, the equalisation of the circulation, the increased secretion from the mucous membrane of the stomach, and also of the duodenum as well as the liver and pancreas, and frequently from the skin.

The secondary effects of nauseating doses are diminished arterial action and augmented absorption.

We shall now state a few of the morbid conditions to which these agents are suited, and a few of those for which they are unfit.

In fever. Whatever opinions may be entertained respecting the nature and origin of fever, there can be no question but that the sanguiferous system powerfully feels and shows disturbance, and in no point more conspicuously than in the capillaries. These become the seat of those morbid actions, to counteract which is the chief aim of the early treatment. By these vessels, too, are executed the functions of secretion, deposition of the nutrient material, exhalation, and, in some degree, the evolution of animal heat. The consequences of deranged action of the capillaries are—diminished or vitiated secretion, suspended nutrition, altered exhalation, and the animal heat augmented or diminished, or unequally diffused. But while the diseased impression is confined to the general circulation, which it always is for some time (varying in different cases and constitutions), the series of morbid actions may be arrested by venesection, purgatives, or more certainly by an emetic. This should be administered at as early a period of the disease as possible; but even should it fail in cutting short the febrile movement, still it clears the stomach, and fits it to retain whatever may subsequently be had recourse to in order to moderate or regulate the future condition of the system. Emetics invariably render the disease milder, owing to the greater freedom of the secretions which follows their use; and they may be advantageously repeated even in the more advanced stage, frequently inducing sleep and a moist state of the skin. They may be employed in epidemic, typhus, common fever, and exanthematous fevers, especially measles, scarlet fever, and small-pox. For the slight febrile affections of children, generally caused by something offending the stomach, nothing is so well suited or so efficacious as a gentle emetic. In bilious fevers emetics are required, especially at the beginning. In intermittent fevers, if given before the paroxysm, they early bring on the sweating stage, thus concentrating the fit into a short period. Their tendency to produce perspiration often renders them useful in rheumatic fevers. In common inflammation of the throat, and still more so in croup, emetics are of decided utility. In common catarrh they frequently shorten the disease; and in the suffocative catarrh and catarrh of old age, emetics mechanically unload the lungs, and render the respiration freer. Dr. James Clark and Dr. Carswell even think that they can dislodge tubercular matter from the lungs in the early stages of consumption. (See Clark 'On Consumption.')

Few agents are more useful in whooping-cough than emetics; and in many cases of indigestion, especially if accompanied with sick headache or hypochondriasis, emetics give effectual relief.

Emetics are very improper where there is a disposition to apoplexy, or tendency of blood to the head, or where the patient is liable to hæmorrhage from any organ, or is subject to hernia. They are also to be avoided during pregnancy.

Emetics are often resorted to when any poisonous substance has been taken. For this purpose a scruple of sulphate of zinc in a tumbler of warm water is proper, or a table-spoonful of common mustard in a tumbler of water. But when opium, belladonna, or other narcotic poison has been taken, emetics rarely act. The stomach-pump should then be used.

EMETINE, *Emeta, Emetia,* a vegetable alkaloid obtained from ipecacuanha-root, and in which the powers of that medicine reside. In order to prepare it, the root is reduced to powder, and then treated with sulphuric ether to separate a fatty substance, and afterwards with boiling alcohol. The alcoholic solutions, when evaporated, leave a bitter brown extract, which contains emetine combined with gallic acid. This is to be redissolved in water, and boiled with an excess of magnesia, which decomposes the gallate of emetine; the magnesian precipitate is to be washed with a little cold water, and then boiled in alcohol. The emetine dissolved in the alcohol is separated by evaporation; but as it is coloured, it is recombined with an acid, and after being decolourised by animal charcoal, it is to be again precipitated by magnesia.

Emetine, when pure, is white, pulverulent, and uncrystallisable; its taste is rather bitter; it melts at 104° Fahr., and afterwards decomposes at a temperature below 212°. It suffers no change by exposure to the air; it is slightly soluble in cold water, but readily dissolved by alcohol; the solution restores the blue colour of litmus paper which has been reddened; it is precipitated by tincture of galls; acids are but imperfectly saturated by it, and it yields with them uncrystallisable salts, which have been but little examined. The gallotannate is neither emetic nor poisonous.

In the dose of half a grain emetine is stated to act as a powerful emetic, and in larger doses its effects are extremely violent.

It is composed of—

Hydrogen	7·77
Carbon	64·57
Oxygen	22·95
Azote	4·30
	99·59

EMIGRATION, may be defined to be a man's leaving his native country with all his property to settle permanently in another. Emigration is therefore necessarily implied in the word colonisation, and it is by the terms of our definition easily distinguished from a man's temporary absence from his native country and from the kind of absence specially called absenteeism,

Though a man may be properly called an emigrant who leaves Great Britain or Ireland, for instance, and settles in France or Germany or elsewhere in Europe, the term has in modern times come to have a more restricted and particular sense. By the term emigrant we generally understand one who leaves an old and thickly peopled country to settle in a country where there is abundance of land that has never been cultivated before, and where the native population is thinly scattered, and the foreign settlers are yet either few compared with the surface, or none at all. The countries to which emigration is mainly directed at present are the British possessions in North America, the United States of North America, the great island of Australia with Van Diemen's Land, New Zealand, and the Cape of Good Hope.

An emigrant to any of these remote countries must be either a capitalist or a labourer. An emigrant may combine in himself both conditions; for even a mere labourer cannot emigrate without some capital, though the amount may be only enough to convey him to the spot where his labour and skill will be in demand. It was long a prevalent notion that emigration should be discouraged or prevented, as tending to weaken a nation. The objection, we believe, was generally founded rather on a notion that the nation lost by its diminished population, than that it suffered from the abstraction of capital. As to the matter of population, however, some observers even then could not fail to remark, that emigration did not seem to diminish the population, but that on the contrary it seemed to be soon followed by an increase. This was observed with respect to Portugal at the time when she was extending her conquests and colonies, and is a fact confirmed by more recent experience, the explanation of which presents no difficulty. The abstraction of capital, skill, and industry might seem, and indeed is primarily, so much good taken from the mother country; but inasmuch as the emigrants retain in their new settlements, through the medium of commercial exchange which is daily becoming more rapid and easy, a connection with the parent state, it may be and often is the fact, that they ultimately contribute more to the wealth of the mother country when in the new settlements than they could have done at home. Many of those, for example, who settle in the western States of America or in Canada with no capital beyond their hands, by their industry become the possessors of a well-cultivated piece of land, and ultimately consume more of the products of British industry, for which they must give something in exchange, than if they had remained in their native country. And as, in order that emigration to new countries may be a successful undertaking to those who emigrate, and ultimately advantageous to the mother country, there must be an emigration both of capitalists and labourers, it would seem to follow that a state, if it consult the happiness of its citizens, should place no impediments to the emigration either of capitalists of all kinds or of labourers or artizans of any kind, but should on the contrary give reasonable facilities.

If a state then should be wise enough not to discourage emigration, it may be asked, should it aid and direct it? So far as a state should aid and direct emigration, there must be two distinct objects kept in view by the state; one must be to benefit the parent country, the other to benefit those who emigrate. On the contrary, as to the individual who emigrates, whether he emigrates under the protection and direction of the government or not, his object generally is of course to better his own condition.

One cannot well conceive why a state, or any section or part of a nation, should make any contribution or raise any fund for the purpose of aiding emigration, except it be with the view of bettering the condition of some who cannot find employment at home, and at the same time adopting some systematic plan for improving the condition of those who are left behind. Yet any system of emigration thus conducted by government, or by societies, or by the inhabitants of particular districts, would fail in its primary object, relief to the emigrants, unless a corresponding amount of capital should be taken out of the country by other emigrants who might settle in the same place to which the emigrant labourers were sent. To effect such an adjustment between capital and labour, not only should both these elements of wealth in due proportion be transported to the new country, but such proportion should, for some time at least, be maintained by the body which superintends such system of emigration; an arrangement which seems impracticable, except by some such provisions as are hereafter mentioned.

It is further to be observed that as no persons can ever succeed as emigrants who are not sober, intelligent, and industrious, and as such alone are consequently fit people to go to a new country, such alone should be sent out by a state or a society, if it interferes in the matter of emigration. But if a large number of the most industrious labourers should emigrate from a given district, and leave behind them the worthless and idle, though the emigrants might better their condition and improve the settlement of which they go to form a part, the mother country would be no gainer by this change. We are not inclined to consider that any advantage, at all commensurate to the expense, would result from any emigration, however extensive, from districts where there is a superabundant and pauperised, or a pauperised and not superabundant population. If the idle, the ignorant, and the vicious, were exported wholesale, they would only die a few years sooner in the land of their new settlement, without conferring any benefit on it, and those of the same kind who were left behind would hardly be more susceptible of improvement for the absence of any part of their numbers which did not amount to pretty nearly the whole number; while the industrious and the intelligent, who, by the supposition, remain at home and are willing to labour whenever it is in their power, would hardly derive any benefit by this removal of the bad from among them, at all commensurate to the amount of capital which must be expended on such wholesale exportations. Besides, as already observed, unless a proper supply of emigrant capitalists can be secured, all general plans for the emigration of labourers can only lead to disappointment and starvation. Any plan therefore which shall have for its object the amelioration of a population sunk in ignorance or debased by pauperism, must be one of an internal character, one which must gradually and on certain fixed principles aim at removing the evils which exist in the social system. Emigration must be left to the free choice of individuals, and must be recommended to the young, the sober, and industrious solely on the grounds of offering to them a reasonable prospect of bettering their condition in a new country.

The disadvantages of emigration however, when there is no plan, no controlling or directing power, are obvious. Emigrants often go to a new country without any definite or clear notion of what they are going to. Dissatisfied or unhappy at home, imagination pictures to them a remote and unknown country as an asylum from all the evils of life; or if they have any distinct idea of the new kind of existence which they are going to adopt, they often underrate the difficulties of the undertaking, or form a false estimate of their own capabilities to meet them. It is no wonder then that so many, on landing in the New World, are startled at the obstacles which then stare them in the face, and shut their eyes to the real advantages, such as they are, which a fertile unoccupied soil presents to a hardworking industrious man.

Years.	North American Colonies.	United States.	Australian Colonies and New Zealand.	All other Places.	Total.
1815	680	1,209	*	192	2,081
1816	3,370	9,022	*	118	12,510
1817	9,797	10,280	*	557	20,634
1818	15,136	12,429	*	222	27,787
1819	23,534	10,674	*	579	34,787
1820	17,921	6,745	*	1,063	25,729
1821	12,955	4,958	*	384	18,297
1822	16,013	4,137	*	279	20,429
1823	11,355	5,032	*	163	16,550
1824	8,774	5,152	*	99	14,025
1825	8,741	5,551	485	114	14,891
1826	12,818	7,063	903	116	20,900
1827	12,648	14,526	715	114	28,003
1828	12,084	12,817	1,056	135	26,092
1829	13,307	15,678	2,016	197	31,198
1830	30,574	24,887	1,242	204	56,907
1831	58,067	23,418	1,561	114	83,160
1832	66,339	32,872	3,733	196	103,140
1833	28,808	29,109	4,093	517	62,527
1834	40,060	33,074	2,800	288	76,222
1835	15,573	26,720	1,860	325	44,478
1836	34,226	37,774	3,124	293	75,417
1837	29,884	36,770	5,054	326	72,034
1838	4,577	14,332	14,021	292	33,222
18[illegible]	12,658	33,536	15,786	227	62,207
1840	32,293	40,642	15,850	1,958	90,743
1841	38,164	45,017	32,625	2,786	118,592
1842	54,123	63,852	8,534	1,835	128,344
1843	23,518	28,335	3,478	1,881	57,212
1844	22,924	43,660	2,229	1,873	70,686
1845	31,803	58,538	830	2,330	93,501
1846	43,439	82,239	2,347	1,826	129,851
1847	109,680	142,154	4,949	1,487	258,270
1848	31,065	188,233	23,904	4,887	248,089
1849	41,367	219,450	32,191	6,490	299,498
1850	32,961	223,078	16,037	8,773	280,849
1851	42,605	267,357	21,532	4,472	335,966
1852	32,873	244,261	87,881	3,749	368,764
1853	34,522	230,885	61,401	3,129	329,937
1854	43,761	193,065	83,237	3,366	323,429
1855	17,966	103,414	52,309	3,118	176,807
1856	16,378	111,837	44,584	3,755	176,554
1857	21,001	126,905	61,248	3,721	212,875
1858	9,704	59,716	39,295	5,257	113,972
Total	1,180,046	2,890,403	652,910	73,807	4,797,166

Average annual emigration from the United Kingdom . .		
	From 1815 to 1858 . .	109,026
	For the 10 years ending 1858	261,865

We have noticed above, that the abstraction of population for the purposes of colonisation appears to promote an increase rather than a diminution in the numbers of the parent state. One of the most remarkable facts in the history of Great Britain is the rapid increase of the population. The positive increase in our own kingdom has been pointed out in the article CENSUS. While the population of France and Germany has increased within the last fifty years in a very small degree; while in Spain, Portugal, and Italy it has probably decreased; Great Britain has increased from 10,800,000, as given in the census of 1801, to 20,900,000 in that of 1851; and in the middle of 1858, the Registrar-General estimated the population of England and Wales alone at 19,523,000: Ireland and Scotland are omitted, as there was no census of 1801. In addition to this increase, swarms have been thrown off to which the ancient migrations from the North are insignificant in their total amount, though the emigration has been less striking from its being not an irruption but a gradual progress. In forty-four years, from 1815 to 1858 inclusive, during which an account of avowed emigrants has been taken, 4,797,166 persons, male and female, have left the shores of the United Kingdom; and these have been enabled to form what may now be termed three mighty empires, subordinate to our own, in Australia, North America, and South Africa; independent of the branch streams which have flown off to Ceylon, the West and East Indies, Guiana, and other British possessions. The United States of America is the only dominion that can afford anything like a parallel, and even that is indebted to us for 2,890,403 persons, who have proceeded thither, the greater proportion of whom have been from Ireland, and chiefly from the years beginning with 1847.

In 1857 the total number of emigrants from the port of Liverpool only, was 155,652; of these 9788 were for the North American colonies; 106,918 for the United States; 32,631 for Australia and New Zealand, and 324 for other places. Of these emigrants England supplied 50,289; Scotland, 8161; Ireland, 71,195; and various foreign countries, chiefly Germany, 6414. The emigration to Australia was principally English; that to the United States principally Irish.

Many emigrants, however, proceed to the North American colonies by New York, and no account is taken of the passage either way on the borders between them and the United States. The population thus exported seems scarcely less fertile than at home. We give the latest returns of the population of these colonies which are mainly occupied by a British population, our youngest and most vigorous:—

In North America:		Males.	Females.	Total.
Canada . .	Western	499,067	452,937	952,004
	Eastern	449,967	440,294	890,261
New Brunswick . . .		99,526	94,274	193,800
Nova Scotia		137,677	138,440	276,117
Prince Edward's Island and Cape Breton . .		36,137	35,365	71,502
Newfoundland . . .		52,274	44,232	96,506
Bermuda		4,797	6,295	11,092
Total . .		1,279,445	1,211,837	2,491,282

The numbers given for Canada are from the census of 1851 for Western, and the official return of 1852 for Eastern Canada; the estimated numbers of both in January 1857 were 2,500,000. For New Brunswick they are taken from the census of 1851, and the official returns of 1858. For Nova Scotia, from the census of 1851. For Prince Edward's Island, the census of 1854; estimated in 1857 at 117,000. All have increased since the returns. For Newfoundland the numbers are taken from the census of 1845, and in 1857 the population was estimated at 125,000. For Bermuda the authority is the official return of 1853.

In Australia:	Males.	Females.	Total.
New South Wales . . .	171,673	133,814	305,487
Victoria	308,983	176,786	485,769
South Australia . . .	55,735	54,182	109,917
Western Australia . . .	9,560	4,733	14,293
Tasmania	45,916	34,886	80,802
New Zealand	29,435	22,720	52,155
" Natives . .	31,667	24,303	55,970
Total	652,969	441,424	1,104,393

The returns for New South Wales are from the census of 1857; for Victoria, the official return of September 30th, 1858; for South Australia, the official return of December 31st, 1857; for Western Australia, the official return of June 30th, 1858; for Tasmania, the census of March 31st, 1857, which includes 3008 convicts, 16 aborigines, and 690 military and their families; for New Zealand, the official statistics of 1857. On June 30th, 1859, the population of Victoria had increased to 517,366, of whom 330,212 were males, and 187,154 were females; the number of Chinese immigrants at that period was 45,160, all of whom were males.

In Africa the principal point of emigration has been the Cape of

---

* The Customs returns do not record any emigration to Australia during these ten years, but it appears from other sources that there went out in 1821, 320; in 1822, 875; in 1823, 543; in 1824, 780; and in 1825, 458 persons. These numbers have not been included in the totals of this Table.

Good Hope and Natal. In these the population, according to the return of 1856, was

		Males.	Females.	Total.
Cape of Good Hope	Western Division	81,347	80,691	162,038
	Eastern Division	52,973	52,085	105,058
Natal		52,045	57,755	109,800
Total		186,365	190,531	376,896

exclusive of 112,988 settled natives in Natal.

In these three divisions of the British colonies, there are now representative governments, the privilege of self taxation, and the right of a free press,—in short, a complete reproduction of the British constitution. To other colonies, especially to British Guiana and some of the West India islands, the emigration has been considerable; but as the emigrants become mixed with an older and in some cases a coloured or foreign population, we cannot trace the British element so clearly. We give, however, the population returns of the other British settlements, with the year of the return:—

		Males.	Females.	Total.
Europe:				
	Heligoland (1857)	957	1,022	1,979
	Gibraltar (1850)	7,752	8,071	15,823
	Malta (1856)	74,225	68,312	142,537
	Ionian Islands (1856)	117,655	100,747	218,402*
West Indies:				
	Jamaica (1844)	181,633	195,800	377,433
	Bahamas (1851)	13,747	13,772	27,519
Leeward Islands.	Antigua (1856)	16,624	18,784	35,408
	Dominica (1856)	10,596	11,624	22,220
	St. Christopher's (1855)	9,525	11,216	20,741
	Montserrat (1851)	3,149	3,894	7,043
	Nevis (1844)	4,418	5,153	9,571
	Tortola (1841)	3,130	3,559	6,689
	Anguilla (1844)	982	1,197	2,179
Windward Islands.	Barbadoes (1856)	62,272	73,667	135,939
	Grenada (1851)	15,713	16,958	32,671
	St. Vincent (1851)	13,957	16,171	30,128
	Tobago (1856)	..	..	15,393
	St. Lucia (1856)	12,136	13,581	25,717
	Trinidad†	40,671	34,221	74,892
	British Guiana (1857)	60,750	52,989	113,739
	Honduras (1856)	..	..	19,500
Africa:				
	Gambia (1856)	3,173	2,520	5,693
	Sierra Leone (1854)	21,153	19,230	40,383
	Gold Coast (1851)	..	..	385,000
	St. Helena (1851)	2,973	2,517	5,490
Other Colonies:				
	Auckland Islands (1851)	..	..	151
	Ceylon (1856)	877,562	799,990	1,677,552
	Mauritius (1856)	161,411	80,436	241,847
	Seychelles (1852)	..	..	6,906
	Hong Kong (1856)	54,531	17,199	71,750
	Labuan (1856)	1,079	183	1,262
	Falkland Islands (1856)	240	170	410

The total amount of the population of the various settlements of Great Britain by these returns is 7,744,422 persons, of whom 3,890,707 are males, 3,426,765 are females, and 426,950 of whom the sex is not distinguished.

The effect has been so far good, that the inhabitants of the North American and Australian colonies are, with the exception of the United States, among our best customers. It is not remarkable, therefore, that so much attention has been paid of late years to the subject of the transmission of emigrants thither, and of means for enabling them to settle there in comfort. Government, accordingly, has undertaken to a considerable extent the business of regulating emigration. First, an agent-general for emigration was appointed. This officer introduced many judicious plans for rendering the passage of emigrants across the ocean as free as possible from discomfort, and a code of rules was framed to secure this and other objects. The functions of the agent-general for emigration are now exercised by the Land and Emigration Commissioners. Emigrants are also protected by the Passengers Act. The Act 5 & 6 Will. IV. c. 5, passed in 1835, having proved insufficient for the purpose, several amended Acts were passed, of which the latest is the 18 & 19 Vict. c. 119, passed in 1855. Its objects are to regulate the number of passengers in each ship, and to provide for their proper accommodation on board; to ensure a proper supply of provisions and water for their use; to provide for the sea-worthiness of the vessels; to secure a sufficient number of boats in case of accidents; and to protect emigrants from the numerous frauds to which at various stages of their undertaking their helplessness and inexperience expose them. If the ship does not sail on the day mentioned in the agreement, the Passengers' Act compels the captain to victual the emigrants just the same as if the voyage had commenced; and they are entitled to remain on board forty-eight hours after the ship reaches her destination.

As a further protection to emigrants, and to enforce the provisions of the Passengers Act, government emigration agents are appointed for the ports of London, Liverpool, Plymouth, Southampton, Glasgow and Greenock, Dublin, Cork, Belfast, Tralee, Limerick, Waterford, Londonderry, and Galway. These officers act under the immediate directions of the Colonial Land and Emigration Commissioners. They procure and give gratuitously information as to the sailing of ships, and means of accommodation for emigrants; and whenever applied to for that purpose, they see that all agreements between ship-owners, agents, or masters, and intending emigrants, are duly performed. They also see that the provisions of the Passengers Act are strictly complied with; namely, that passenger-vessels are sea-worthy, that they have on board a sufficient supply of provisions, water, medicines, &c., and that they sail with proper punctuality. They attend personally at their offices on every week-day, and afford gratuitously all the assistance in their power to protect intending emigrants against fraud and imposition, and to obtain redress where oppression or injury has been practised on them.

In the colonies there are Government Emigration Agents at the following places:—

Canada.—Quebec, Montreal, Ottawa, Toronto, and Hamilton.

New Brunswick.—St. John's, St. Andrew's, Chatham (Miramichi), Bathurst, Dalhousie, and Richibucto.

Australian Colonies.—Sydney, Queensland (late Moreton Bay), Melbourne, Geelong, Portland Bay, Hobart Town, Launceston, Perth, Fremantle, Adelaide, and Auckland.

Cape of Good Hope.—Cape Town, Port Elizabeth, Simon's Town, and Natal.

And also in Jamaica, Bahamas, British Guiana, Trinidad, Nevis, Sierra Leone, and St. Helena.

The duty of these officers is to afford gratuitously to emigrants every assistance in their power by way of advice and information as to the districts where employment can be obtained most readily, and upon the most advantageous terms, and also as to the best modes of reaching such districts.

The Emigration Commissioners, while they have funds for the purpose, grant passages to New South Wales, Victoria, South Australia, the Cape of Good Hope, and Natal, to persons strictly of the labouring class who may be considered eligible emigrants. The funds are supplied entirely from colonial revenues, and in the administration of them the commissioners act as trustees for the colonies, and are therefore bound to look exclusively to colonial interests. They do not consider, therefore, how distress in this country may be best relieved, but how the largest number of emigrants most suited for the wants of the colony may be procured and sent out. In deciding what classes are most suited to the wants of the colonies, the commissioners are guided by reports and instructions received from time to time from the governments of the respective colonies, either direct or through the secretary of state. The commissioners are occasionally also able to grant passages to Western Australia; but they have no funds for assisting persons wishing to emigrate to the North American colonies.

In British Guiana, the Governor, under Ordinance No. 7, of 1854, sect. 4, is authorised by proclamation to name the places from which emigration on bounties is permitted, and to fix the rates of bounty for the introduction of emigrants, under the age of forty, competent and willing to engage in agricultural labour.

Emigration is one of the "modes of relief" contemplated by the Poor Law Amendment Acts (4 & 5 Will. IV. c. 76; 11 & 12 Vict. c. 110; 12 & 13 Vict. c. 103; and 13 & 14 Vict. c. 101). In some years a large number have emigrated with the assistance of funds obtained under the act, 4 & 5 Will. IV. By sect. 62 of that act, owners and ratepayers are empowered to raise money on security of the rates for the purposes of emigration, under the authority of the Poor Law Commissioners. The sum so raised must not exceed half the average yearly rate of the preceding three years, and it must be repaid within five years. The money is advanced to emigrants by way of loan, and is recoverable against persons above the age of twenty-one, who, having consented to emigrate, refuse to do so after the expenses of emigration have been incurred; and the loan is also recoverable if persons who emigrate shall return to this country. By the 12 & 13 Vict. c. 103, the guardians of any parish or union are empowered to expend money to the amount of 10*l.* upon the emigration of any poor person belonging to the parish or to any parish in the Union, without the necessity of a parochial meeting to give their consent. But the gross amount expended must not exceed the limit fixed above, and a majority of the guardians of the parish of the settlement must express their concurrence in writing in the resolution of the Board of Guardians for such expenditure. This written concurrence must be transmitted, together with a list describing the proposed emigrants, to the Poor Law Board, who are to issue their order to confirm the resolution. The 13 & 14 Vict. c. 101, s. 4, enables Boards of Guardians, under similar restrictions, to expend money in and about the emigration of orphan or deserted children under sixteen having no settlement, or whose settlement is unknown. But it requires that no emigration of any such orphan or deserted child shall take place without the consent of such child given in petty session, and unless a certificate thereof under the hands of two justices shall have been transmitted to the Poor Law Board. Certain conditions are inserted by the Poor

---

* Exclusive of 8704 aliens.

† In Trinidad the estimated population in 1857 was 80,000.

Law Board in all orders sanctioning the emigration of poor persons, of which the most material is, that the party emigrating shall go to some British colony not lying within the tropics; and the guardians are empowered to expend certain specified sums in the conveyance of the emigrant to the port of embarkation, and on the outfit, including bed, bedding, and clothing.

Under the Irish Poor Law Act, money may be raised for enabling poor persons to emigrate to British colonies; but the money so raised must not exceed one shilling in the pound on the net annual value of rateable property.

The Bounty System derives its name from the mode in which the proceeds of land-sales are applied in obtaining immigrants. In this case persons who introduce persons into the colony receive so much per head according to the terms of agreement. The contractors engage to find persons willing to emigrate, and undertake to land them in the colony. This system is in force only in some of the Australian colonies. In New South Wales 51,736 persons were introduced from 1831 to 1842 under bounties.

The mode in which unoccupied land is disposed of in the colonies has a most important influence on the condition and welfare of immigrants. By the application of a general principle of law, the waste lands in the British colonies were considered to be vested in the Crown, and that every private title must rest upon a royal grant as its basis. But since 1831 another principle has been acknowledged and observed: that the crown holds the lands in question for the purposes of the public good, not merely for the existing colonists, but for the people of the British empire collectively. It must be appropriated to the public uses and for the public benefit. The Land Sale Act for the Australian Colonies (5 & 6 Vict. c. 36) prohibits land being alienated by her Majesty, or by any one acting under her authority, except by sale, and in the manner directed by the act.

Down to the year 1831 no regular or uniform system of selling land appears to have been adopted in the British colonies. In place of such system, conditions were attached to the occupation of land under the name of quit-rents, money payments, or the cultivation of the soil; but these conditions were not effectually enforced, and in fact it was generally found impossible to enforce them. Land was profusely granted to individuals in large tracts, and as cultivation was not enforced, and no roads were made through these tracts, they interrupted the course of improvement. Under the old system, lands in the colony of the Cape of Good Hope, amounting to upwards of thirty-one million acres, have been disposed of for less than 46,000*l.* In Prince Edward's Island the whole of the land was granted in one day to absentee proprietors upon terms which have never been fulfilled. The influence of these proprietors with the Home Government prevented such measures being adopted as were calculated to enforce the settlement of the grants, and consequently the greater part of them remained chiefly in a wild state. ('Report of Mr. C. Buller, M.P., to the Earl of Durham, on Public Lands in British North America,' 1838.) This report contains an account of the system of granting lands in each of the provinces of British North America; and in all of them it appears to have been injurious to the public interests.

In January, 1840, commissioners were appointed under the royal sign manual to act as a Land and Emigration Board. The sale of the waste lands of the Crown throughout the British colonies was regulated by the commissioners, and they applied the proceeds of such sales towards the removal thither of emigrants from this country, when the land-fund was appropriated to this object. This board was a subordinate department of the Colonial Office. But the disposal of the waste lands is now, by various acts of the imperial and provincial parliaments, vested in the local governments. The regulations vary considerably in their details, but we give a summary of the conditions and prices of the waste lands in the North American, Australian, and Cape of Good Hope Colonies.

Colony.	Mode of Sale.	Price per Acre.
North American Colonics:		
Canada (West) . .	Fixed price . .	4*s.* to 20*s.* currency.
Canada (East) . . .	Ditto . . .	2*s.* to 4s. do., according to situation.
Nova Scotia . . .	Ditto . . .	1*s.* 9*d.* sterling.
New Brunswick . .	Auction and private sales . . .	2*s.* 5*d.* sterling upset price, and 2*s.* 1*d.* at private sale.
Newfoundland . . .	Ditto . .	2*s.* currency upset price.
Prince Edward Island . .	Private contract .	5*s.* and upwards, according to situation.
Australian Colonies:	By Auction.	
New South Wales . Victoria . . . Western Australia . South Australia . . Tasmania . .	Country lands not sold at the public sales may afterwards be bought at the upset price as a fixed price.	Lowest upset price, 1*l.* sterling.
New Zealand [Crown lands] . . .	Auction, for town, suburban, and rural lands. Fixed price for country lands.	Highest fixed price, 10*s.* an acre.
Cape of Good Hope. .	Auction, subject to a quit-rent . .	No fixed upset price.
Natal	Ditto . .	Lowest upset price, 4*s.* sterling.

In Canada there are detached Clergy Reserves for sale in most of the townships surveyed prior to 1841. These reserves are now vested in the Colonial Government by the 16 Vict. c. 21 (1853), subject to the rights of the clergy. They are now thrown open for public sale. The lands reported by the chief agent for emigration at Quebec to be most worthy the attention of emigrants, are the townships Peel, Wellesley, Maryborough, and Mornington, covering an area of 250,000 acres, in the county of Waterloo. The prices of land in these townships (as of all clergy reserves), are regulated by the quality of soil and situation, and average from 8*s.* to 20*s.* currency per acre, one-tenth of the purchase-money being required at the time of sale, and the remainder to be paid in nine annual instalments, with interest. One million acres of land were also appropriated for school purposes by the legislature in 1849, and the school lands in the counties of Bruce, Grey, and Huron, are now open for sale to actual settlers upon the following terms:—The price to be 10*s.* per acre, payable in ten equal annual instalments, with interest. The first instalment to be paid upon receiving authority to enter upon the land. Actual occupation to be immediate and continuous. The land to be cleared at the rate of 5 acres annually for every 100 acres during the first five years. A dwelling-house at least 18 feet by 26 to be erected. The timber to be reserved until the land has been paid for in full and patented, and to be subject to any general timber duty thereafter. A licence of occupation, not assignable without permission, to be granted. The sale and the licence of occupation to become null and void in case of neglect or violation of any of the conditions. The settler to be entitled to obtain a patent upon complying with all the conditions. Not more than 200 acres to be sold to any one person on these terms.

In Canada West, the provincial government have opened three great lines of road, and laid out for settlement the lands through which they pass. They are styled—1st, The Ottawa and Opeongo Road, which runs east and west; it will eventually be 171 miles in length, and connect the Ottawa River with Lake Huron. 2nd, The Addington Road, which runs north and south, is 60 miles long, and starts from the settlements in the county of Addington until it intersects the Opeongo Road. 3rd, the Hastings Road, which runs nearly parallel to the Addington Road, is 74 miles long, and connects the county of Hastings with the Ottawa and Opeongo Road. In order to facilitate the settlement of this part of Canada, and to provide for keeping the roads in repair, the provincial government have authorised free grants of land along these three roads, not to exceed in each case 100 acres, upon the following conditions: That the settler be eighteen years of age. That he take possession of the land allotted to him within one month, and put in a state of cultivation at least twelve acres of the land in the course of four years; build a house, at least 20 by 18 feet; and reside on the lot until the conditions of settlement are duly performed. Families comprising several settlers entitled to lands, preferring to reside on a single lot, will be exempted from the obligation of building and of residence (except upon the lot on which they live), provided that the required clearing of the land be made on each lot. No title is given to the settler until after these conditions have been performed, and the non-performance of them entails the immediate loss of the assigned lot of land, which will be sold or given to another.

The road having been opened by the government, the settlers are required to keep it in repair. The log-house required by the government to be built is of such a description as can be put up in four days by five men. The neighbours generally help to build the log-cabin for newly-arrived settlers without charge, and when this is done the cost of erection is small: the roof can be covered with bark, and the spaces between the logs plastered with clay and white-washed; it then becomes a neat dwelling, and as warm as a stone house.

The lands in Canada West thus opened up for settlement are capable, both as to soil and climate, of producing abundant crops of winter wheat of excellent quality and full weight, and also of every other description of farm produce grown in the best cultivated districts of that province.

In Australia and New Zealand, licences and leases are granted for large tracts of land for pasturage purposes, at very low rents, as to which the holders have certain restricted rights of pre-emption if required for purposes of cultivation, and subject to the right of being taken by the government if wanted for public purposes.

In all the colonies the rights of the crown in regard to minerals are preserved; but in most cases leases are granted on payment of a certain rate per cent. on the produce. In Australia, licences to mine and dig for gold on crown lands are granted at the rate of 10*s.* per month for each individual licence, payable in advance; or in case of a lease being granted of a certain portion of land, at a rate of 3 per cent. on the gross value of the gold procured from crown lands, and of half that amount on gold obtained from private lands. A "miner's right" licence to search and dig for gold is obtainable on payment in advance of 1*l.* per annum. "Storekeepers' licences" at the "Diggings" are also paid for at the rate of 2*l.* 10*s.* for three months, 5*l.* for six months, and 10*l.* for twelve months.

The Land and Emigration Commissioners are required by their official instructions to prepare and issue "a distinct and compendious account of whatever relates to the agriculture, the commerce, the natural products, the physical structure, and the ecclesiastical and political institutions of each of the colonies in which they offer land for sale." The Commissioners, in pursuance of this object, issue occasionally a 'Colonisation Circular,' which contains matter calculated to be of essential use to emigrants or persons who intend at some time to settle in the colonies.

EMPANNEL, the writing and entering the names of a jury on a parchment schedule or roll of paper by the sheriff. [PANEL.]

EMPEROR, from the Latin *imperātor*. Among the early Romans the title of Imperator was bestowed by the acclamations of his soldiers in the camp, and by a vote of the Roman senate, on a commander-in-chief who had signalised himself by killing a certain number of the enemy. (Tacit. 'Annal.' iii. 74.) The term was gradually extended to signify a commander-in-chief sent on any important expedition. (Cic. 'Pro Lege Manil.,' c. 2.) But it still continued usual for the appellation to be bestowed as a special title of honour for some military service; thus we find that the small military exploits of Cicero conferred on him the title of Imperator. C. J. Cæsar assumed the name as a prænomen (Imperator C. J. Cæsar), a practice which was followed by his successors, as we may observe on their coins. (Suetonius 'Cæsar,' 76.) As examples of this title see the coins of ANTONIUS, AURELIUS, &c., in BIOG. DIV. On the reverse of the coin of Aurelius we observe Imp. VIII., that is, Imperator octavum, or imperator the eighth time, which shows, as indeed can be proved from a variety of examples, that the Roman emperors often assumed the title on special occasions when they or their generals had obtained some signal victory. This term Imperator then, it will be observed, under the early emperors, cannot be considered as denoting any sovereign power. It was indeed given to private individuals on the occasion of great military success, certainly as late as the time of Hadrian, and perhaps later. (Appian 'Civil Wars,' lib. 2.)

After the time of the Antonines the term Imperator seems to have gradually grown into common use as one of the titles which expressed the sovereign of the Roman world, though the name Princeps was also long used as indicating the same rank and power. (See the Dedication of J. Capitolinus to Constantine.) It may be difficult to state when this term Imperator became exclusively the designation of the Roman sovereign. In the introduction to the Digest (De Conceptione Digestorum), Justinian assumes the title of Imperator Cæsar Flavius Justinianus, &c., semper Augustus. [AUGUSTUS; in BIOG. DIV.] In the proœmium to the Institutes, Justinian uses the terms Imperatoria majestas to express his sovereign power, and yet in the same paragraph he calls himself by the name of Princeps, a term which dates from the time of the so-called Republic, and expressed the precedence given to one particular member of the senate. The term Princeps was adopted by Augustus as the least invidious title of dignity, and was applied to his successors.

From the emperors of the West this title, in the year 800, devolved to Charlemagne, the founder of the second or German empire of the West. Upon the expiration of the German branch of the Carlovingian family, the imperial crown became elective, and continued so until the last century. The title of emperor of Germany now no longer exists, Francis II. having laid it aside, and assumed the title of emperor of Austria. [AUSTRIA, in GEOG. DIV.] The only other European potentates who use the style of emperor are the autocrat of Russia, the monarchs of which country, about the year 1520, exchanged their former title of duke or great duke of Russia for that of Czar or Tzar; and the emperor of the French. In early times it was asserted by the civilians that the possession of the imperial crown gave to the emperors of Germany, as titular sovereigns of the world, a supremacy over all the kings of Europe, though such was never attempted to be exercised; and they denied the existence of any other empire: but in spite of this denial it is certain that several of the kings of France of the second race, after they had lost the empire of Germany, styled themselves Basileus and Imperator. Our own king Edgar, in a charter to Oswald, bishop of Winchester, styled himself "Anglorum Basileus omnium que regum insularum oceani que Britanniam circumjacentis cunctarum que nationum quæ infra eam includuntur *Imperator et Dominus*." Alfonso VII. also, in the 12th century, styled himself emperor of Spain. It might be easily shown how the title and rank of king and emperor have been feudalised, as it were, in passing through the ordeal of the middle ages.

EMPHASIS, in articulation, is the mode of drawing attention to one or more words in a sentence by pronouncing them with a greater volume and duration of sound, and in a higher or lower note, than the adjoining words. In written language there are several symbols by which emphasis is denoted. In manuscript the emphatic word is commonly underlined; in printing it is common to employ a different character, particularly the inclined character called the italic. The German printers have introduced the mode of placing the letters of the emphatic word farther apart from one another. In modern languages the employment of some symbol for emphasis is more requisite than in the ancient languages. In the latter, where the arrangement of words was less fixed, it was generally practicable by the very position of a word in a sentence to denote its emphatic power. Thus, in the Latin language, the first word of a sentence, or even of a clause, is generally emphatic; so also is the last word; and even in the middle of a sentence the verb is often so placed as to give emphasis to the preceding word.

EMPHYTEUSIS (*ἐμφύτευσις*). The term expresses in the Roman law a perpetual right to the enjoyment of land, on condition of paying annually a fixed sum (canon vectigal, pensio) to another person who was considered the owner of the land, and of keeping the land itself in good cultivation. Some writers, indeed, have explained the term to be property in *waste* lands, given on the condition of cultivating them and paying a certain rent. Savigny, whose deep researches into the Roman law, have thrown light upon many obscure and imperfectly understood passages, by contrasting the right of emphyteusis with the tenants of the Ager Vectigalis, has shown the important bearing of each of these kinds of possession the one upon the other, maintaining that both of them are to be considered not as a species of property (like land in the provinces), but as rights *jura in re;* for the Roman jurists, he says, expressly ascribe to the hereditary tenant a *jus in fundo* or *jus prædii;* who in the imperial constitution is always distinguished from the dominus (the landlord). The occupier was called emphyteuta, and the owner of the land dominus emphyteuseos.

The title of the emphyteuta depended on his paying what he had contracted to pay, and also all the taxes to which the property was liable. If he neglected to pay these dues for three years he might be ejected out of the land by the owner, without having any compensation for his improvements. He could alienate the land after giving notice to the owner, who might, however, if he pleased, take the land at the price of the emphyteuta. If he did not, then the emphyteuta could sell it to any person who was able to answer all the demands to which the land was subject by virtue of the contract. In each case the owner was bound to receive the purchaser as his emphyteuta, and confirm his title in due form, for which he could claim a payment not exceeding a fiftieth part of the price at which the land was sold.

The relation between the emphyteuta and the owner originated either in a direct grant from the dominus to the emphyteuta, made either in the form of an agreement or by way of actual conveyance and delivery (*traditio*), or else by the emphyteuta acquiring a prescriptive right by a tenancy of 10 or 20 years' duration, in which case a grant made by one who was not the dominus became valid and effectual at the end of the above period. The owner could also make an emphyteusis by his will.

The emphyteutic contract does not appear in its special form till the reign of Zeno, for though it had an earlier existence as a contract, yet its nature had been much discussed, and whether it was like *locatio conductio*, or like *venditio*, could not be settled till Zeno first, and after him Justinian, gave it a special name and a peculiar action. The Digest is the oldest extant authority in which the term emphyteusis occurs, s. 27, 9, 3, 4. The use and enjoyment expressed by the word emphyteusis were always carefully distinguished from ownership; the emphyteuta was a perpetual lessee who paid a perpetual rent to the owner.

(The subject of the emphyteusis is discussed in the *Inst.*, 3, 24, 3; *D.* 6, 3; *D.* 39, 4; *Cod. Theod.*, 10, 3; *Cod. Justin.*, 4, 66; Mühlenbruch, *Doctrina Pandectarum;* Savigny, *Das Recht des Besitzes*, p. 99, &c., 5th ed.; and Mackeldey, *Systema Juris Romani.* The reader is also referred to a learned note in Hargrave and Butler's edition of *Coke upon Littleton*, 64 a (n. 1), and 191 a (n. 1); to Sir F. Palgrave's *English Commonwealth*, ii., 208; and to Mr. Hallam's *History of Europe during the Middle Ages*, 10th edition, vol. i., p. 314, et seq.)

EMPIRIC. This word is derived from the Greek (ἐ[illegible]ικὸς empeírikos), and means a man who derives his knowledge from experience. A medical sect which arose in opposition to that of the dogmatics assumed the name of empirics. Serapion of Alexandria and Philinus of Cos are regarded as the founders of this school. Ever since the world has existed, the human mind, in striving to find out the principles of truth, has considered the matter in two opposite ways. According to one system, the human mind contains the seeds of knowledge; according to the other, the mind is nothing but a blank sheet of paper, on which experience writes that which man perceives through the senses. Aristotle and Plato are still the representatives of the two opposite systems.

The science of medicine has been of necessity under the influence of one of the two opposite opinions, and the doctrine of Serapion or Philinus is nothing but the application of the Aristotelian theory, that nothing can be known by the understanding which has not been previously known by the senses.

Accordingly they maintained that experience was the only true knowledge which was derived from the unerring testimony of the senses; that dogmatism was erroneous, because it derived its principles from mere imagination. They opposed to the theorists their contradictions, and sneered at their learning and acuteness of reasoning as inadequate means of curing diseases.

The empirics admitted three kinds of experience, the one acquired by chance, the second by experiments, the third by imitation; and these three they called the tripod of medical science. However, it is evident that their mode of experience is nothing but a disguised mode of reasoning by analogy. Epilogism, as they called it, is as theoretical as pure dogmatism; for, how can we judge by analogy, if we do not assume some general laws to which the particulars are subjected?

If the empirics had remained true to their principles their name would stand high among the medical profession. But having abandoned the study of nature, and with it all scientific pursuits, they sank into such disrepute, that their name became a stigma. And even in our days when the natural sciences have, by the impulse given by Lord Bacon to genuine experiment, risen to a high degree of perfection, and empiricism is the character of modern science and philosophy, the name of empiric is still bestowed as an opprobrious term upon all ignorant pretenders in the medical art.

(Curt Sprengel, *Geschichte der Medizin.*)

EMPYE'MA (*ἐμπύημα*, from *ἐν*, 'in,' and *πῦον*, 'pus,' a word which signifies an internal collection of pus). Although this term was restricted by the ancients to purulent collections in the thorax, it is now employed to signify all collections in the pleura which do not arise from an obstruction to the circulating system, and are not of a gaseous nature. In a natural state the pleura, like other serous membranes, secretes a clear fluid, which is removed by absorption as quickly as it is formed. But from the existence of inflammation or the presence of foreign bodies, other fluids often accumulate. The most common of these are serum, blood, pus, and fibrinous matter. Any of them may be present alone, or may be mixed in varying proportions. It is, however, almost impossible to ascertain by any external means the nature of the fluid which has accumulated. Dr. Townsend relates two cases of empyema: in the one, a case of two months' standing, produced by the bursting of a tubercular abscess in the lungs; on the fluid being removed, it presented all the characters of pus; in another case, arising from the same cause, a perfectly transparent and colourless fluid was found. It is therefore not only difficult to discover the nature of the fluid, but the same exciting cause may give rise to the presence of different kinds of fluid.

Whatever may be the nature of the fluid in the lungs, it always exists in conjunction with a peculiar state of the pleura. This membrane is covered over to a greater or less extent with a fibrinous secretion, which, in this and other cases becoming organised, constitutes what are known by the name of false membranes. This fibrinous matter is sometimes deposited in so large quantities on the pleura, which covers the lungs, that even after the fluid is removed, the lungs, which have been compressed, cannot expand, and consequently the parietes of the chest fall in and occupy the vacant space, and contraction of the chest is produced. The false membranes thus produced are liable to various diseases, and they may inflame, ulcerate, or become ossified, and thus produce various secondary diseases. Sometimes the false membranes extend from one side of the cavity of the pleura to the other, and a case is related by Dr. Townsend of a person "in whom the effusion was divided by these partitions into three compartments, so perfectly distinct from each other, that had the operation of paracentesis been performed during life, that compartment only could have been evacuated into which the incision had been made; so that in order to draw off the entire effusion it would have been necessary to perform three several operations."

The worst effect of the presence of fluid in the pleura is exerted on the lung. By its pressure the lung becomes incapable of expanding for the admission of air. Its position is generally by the side of the spinal column, but through the deposition of the fibrinous matter the pleura of the lungs and of the ribs often contract adhesions, and in this manner the lungs may be forced to occupy very varied positions in the cavity of the thorax. When the effusion is extensive the lung becomes flattened and flaccid, its surface is corrugated, and its tissue becomes soft, [illegible]nt, and dense, exhibits no crepitation, and is almost entirely deprived of blood. It does not often inflame in this state, but frequently becomes the seat of the deposition of tuberculous matter.

Empyema is always attended with inflammation acute or chronic of the pleura [Pleuritis], although the bursting of an abscess or the wounding of a blood-vessel may assist in producing the accumulated fluid contents of the pleura; at the same time it frequently happens that the inflammatory symptoms are of so mild and insidious a nature that they are entirely overlooked. This was more frequently the case previous to the use of percussion and auscultation than at the present day. It is in fact impossible by general symptoms alone to infer the presence of empyema. The following symptoms however, taken with the physical signs, may be regarded as characteristic:—Difficult respiration, increased by motion, exertion and lying on the sound side; fulness and oppression at the chest; enlargement of the diseased side; protrusion of the intercostal spaces, with an obscure sense of fluctuation and œdema of the integuments; dulness of sound on percussion, and absence of the respiratory murmur on the diseased side, which remains perfectly motionless; noisy respiration in the opposite lung with violent action of the respiratory muscles; displacement of the heart; protrusion of the abdomen; a harassing short cough, small rapid pulse, and the other symptoms of hectic fever. To these symptoms some would add ægophony, a sound on speaking like the bleating of a goat, but this only occurs when there is a thin stratum of fluid in the pleura, and it is absent when the empyema is extensive. The intensity of all these symptoms is proportionate to the quantity of fluid effused, the duration of the disease, and the constitutional strength of the patient. The difficulty of breathing is in proportion to the quantity of the fluid which presses on the lungs. The inability to lie on the sound side arises from the pressure of the fluid upon the sound lung when a person lies so that its weight comes directly upon it. The cough is not a constant symptom, and may be entirely absent where there is no inflammation of the lungs or bronchiæ. The hectic symptoms will vary according to the strength of the individual and the duration of the disease. Night-sweats do not occur in conjunction with the other hectic symptoms in empyema, unless the lung is in a state of tuberculous ulceration.

There are few diseases with which empyema is likely to be confounded. Its general symptoms resemble those of tubercular phthisis, but the history of the disease, and more particularly the stethoscopic signs will point out the distinction. In phthisis there is no displacement of the heart; absence of the respiratory murmur is usually found at the upper part of the lung, and is followed by mucous râle, pectoriloquy, &c. Hepatisation of the lungs has been referred to as likely to be confounded with empyema, but this is so rare a disease in a chronic form, as to render it unnecessary to point out the distinction between the two diseases here. The same remark applies also to tumours in the sac of the pleura, which, although they have been recorded, are too rare to need a description. Enlargement of the liver, with that organ pressing upon the diaphragm and lungs, might produce the same symptoms as in empyema, but a careful examination in connection with hepatic symptoms would soon indicate the diagnosis.

The treatment of empyema may be of two kinds, medical and surgical. The general principles on which the first should be conducted are those which would be applied in pleuritis. [Pleuritis.] It, however, often happens that the resources of medicine fail, and that no other chance of relief can be offered the patient than that of drawing off the effused fluid by means of an operation. This is called the operation of empyema, or paracentesis thoracis. This operation, although in modern times it has got much into disrepute, was performed by Hippocrates (Hipp., 'De Morbis,' lib. ii. 576; Galen, 'Comment.,' Aph. 27) and the older practioners of surgery with apparently much success. It has recently been recommended, especially by Laennec, in cases of empyema which do not offer a chance of being cured by medical treatment. In such cases, where all other remedial means have been tried, there seems an increasing conviction that this operation may be had recourse to with every chance of benefit: and cases have now been recorded, both in the practice of the French and English hospitals, in which a large proportion of those operated on have recovered. Another class of cases in which paracentesis has been recommended, are those in which the empyema is dependent on acute inflammation of the pleura, and in which the fluid accumulates so rapidly as to threaten suffocation unless removed.

In the performance of paracentesis, the most eligible spot for the operation is between "the fifth and sixth, or the sixth and seventh true ribs, at the point just in front of the indigitations of the serratus magnus, or midway the anterior and lateral parts of the chest." Some surgeons however recommend that it should be done between the third and fourth ribs on the left side, and the fourth and fifth on the right, as they suppose there is danger of wounding the liver or diaphragm by operating lower down. The integuments should be drawn on one side, if it be intended that the wound should close after the operation, and the incision through them should be about two and a half inches long. The intercostal muscles will thus be exposed, and should then be cautiously divided; and when the pleura which lines the ribs is exposed, a small puncture should be carefully made in it. In dividing the intercostal muscles, the knife should be kept close to the upper edge of the lower rib, in order to avoid the risk of wounding the intercostal artery, which runs in a groove upon the lower edge of the upper rib. The size of the opening into the pleura must be regulated by the nature of the effused matter. A canula, supplied with a stopper, should then be introduced and kept in the wound, so that the whole or a part of the fluid may be drawn off.

(*Cyclopædia of Practical Medicine*, article 'Empyema;' Cooper, *Dictionary of Surgery; First Lines of Surgery.*)

EMPYREUMA denotes the peculiar and disagreeable smell and taste resulting from the action of a considerable degree of heat upon vegetable or animal substances in close vessels, which prevent such an access of air as is required for perfect combustion: in this way destructive distillation goes on so as frequently to produce an oil which has a strong, burnt, or, as it is termed, empyreumatic smell and taste.

EMULSIC ACID. [Ferment, *Emulsin*.]

EMULSIN. [Ferment.]

EMULSION, a term applied to mixtures which generally have a milky appearance, and which in some cases, are partial solutions, in others merely mechanical suspensions of oily or resinous substances: thus, the oil of the almond seed may be for a time diffused through water by trituration, but will ultimately separate and float on the surface. Many resins are formed into emulsions by means of the yolk of an egg, or of gum-arabic; while gum resins contain in themselves the means of forming emulsions with water. Frequently syrups and distilled waters are added to render the compound more palatable; but alcohol and acids should never be used. Emulsions should be used soon after being formed, as in a few hours the constituent parts separate or become acid. Almonds and some other substances are directed to be kept in the state of dry confections [CONFECTIONS], and these can immediately be formed into emulsions by trituration with either pure or distilled aromatic waters. Castor oil may readily be made into an emulsion by merely mixing it, and stirring it well, in warm milk or coffee. By this means it not only acts more rapidly, but a much smaller dose is required. It can also be formed into a real emulsion by mixing it in any aromatic water, such as dill or cinnamon, to which a few drops of caustic potass (liquor potassæ), have been added. But in this latter case, the large ordinary dose is needful.

EMYDIN. A neutral azotised substance contained in the yolk of tortoises' eggs, and bearing a considerable resemblance to ICHTHIN. According to the analysis of Fremy, it consists of

Carbon	49·4
Hydrogen	7·4
Nitrogen	14·6
Oxygen Phosphorus	

Emydin presents the appearance of white, hard, and transparent grains, very soluble in dilute solution of potash. It dissolves in boiling hydrochloric acid, without producing a violet colour; in acetic acid it swells up, but does not dissolve. On incineration it leaves about one per cent. of a calcareous ash.

ENAMELS AND ENAMEL-WORK. The subject of this article will best be treated under three sections—Enamels, in their character and mode of employment; enamel-painting, as a branch of the fine-arts; and enamelled-ware, as a manufactured product.

1. *Enamels.*—These are vitrifiable substances, or a peculiar preparation of glass, to which different colours are given, sometimes preserving, sometimes depriving it of its transparency. Artists and jewellers distinguish three kinds of enamels; those which are used to imitate precious stones, those employed in enamel painting (painting on enamel), and those with which an infinite variety of small works are made. The preparation of enamels is very various. In general, ten parts of lead and three parts of tin are oxidised by continued heat and exposure to air. To the mixed oxides thus obtained must be added ten parts of powdered quartz or flint and two parts of common salt, and the whole must be properly melted in a crucible; thus we obtain a white enamel and the basis of coloured enamel, metallic oxides being added in the preparation at the very beginning to give the required colour. The addition of oxide of lead or antimony produces a yellow enamel; reds are obtained by a mixture of the oxides of gold and iron, that composed of gold being the most beautiful and durable. The oxides of copper, cobalt, and iron, give greens, violets, and blues; and a great variety of intermediate colours is produced by mixing them in different proportions. The oxides are sometimes mixed before they are united to the vitreous basis. These are the principal ingredients in the composition of enamels; but the proportions in which they are used, the degree and continuance of the heat required for their perfection, are secrets which the manufacturers carefully keep to themselves as far as they are able.

The art of practically applying these enamels is of great antiquity. It was practised by the Egyptians, from whom it probably passed to the Greeks, and subsequently to the Romans, who are supposed to have introduced the art into Britain. The art continued to be practised by the Byzantines and by the ecclesiastical artists of the middle ages. In this country it was in use among the Britons, the Saxons, and the Normans successively, as is proved by various specimens still existing; and thence down to our own times. Anciently enamels were principally applied to ornamental purposes; but since the invention of clocks and watches their usefulness has increased in an extraordinary degree, there being probably no substance for dial-plates equal to enamel in durability and beauty. The various processes in the practice of enamelling, like the composition of enamels noticed in the last paragraph, have probably never been completely made known to the public; they require extraordinary care and attention, and artists who may have been so fortunate as to discover any improved mode of operating are commonly too jealous to make it known.

Enamels being commonly laid on a metal ground, the first business is to prepare the plates, technically called *coppers*, to receive the enamel. This preparation requires much care and nicety, and the process is extremely curious. The metals used to enamel upon are gold, silver, and copper. Of the other metals some are too fusible to bear the fire, and the others, as platinum, &c., are too *strong*, as it is termed, for the enamel. The best substance to enamel upon is gold, the richness of the colour giving a beautiful tinge through the enamel; but, except for watch-cases and valuable articles of jewellery, copper is generally used on account of its cheapness. Both the gold and the copper should be of the finest kinds.

Enamelling is divided chiefly into two branches, dial-plate enamelling and transparent enamelling; the former including the manufacture of clock and watch plates, with fluxed plates for enamel painting; the other the enamelling of watch-cases, brooches, and other trinkets. The artistic branch is noticed here; various applications to the useful arts will be treated in the latter part of this article. The enamel as it comes from the maker is commonly in small cakes four, five, or six inches in diameter. In preparing it for use it is split, by means of a small hammer applied to the edge of the cakes, into thin flakes, which are put into an agate mortar and finely pulverised; the powder is then washed with water. The moistened mass is laid very smooth on the metal ground with a spatula, and when dried is melted, or, as it is called, *fired*, under a muffle, in a small furnace heated with coke and coal. The back of the coppers is first covered with enamel, and then the face, to which two coats are given, the operation of firing being applied to each. The plates are then carefully polished, for which various substances are used; and when this is complete, they are put for the third and last time into the fire before painting.

2. *Enamel Painting.*—Supposing an enamelled gold or copper plate to have been prepared, we have next to notice the difficult and delicate process of enamel painting. This art, which should be called painting on enamel, is of modern date. It has indeed been supposed that the encaustic painting of the ancients was the same thing as our enamel painting. But though the ancients possessed the art of colouring glass, which might have led to enamel painting, they do not seem to have acquired this latter art, the invention of which, as it is practised in our days, is ascribed to the French. In 1632, Jean Toutin, a goldsmith at Châteaudun, painted on enamel; and he and his disciple, Gulden, taught others. Jean Petitot, born at Geneva in 1607, an admirable painter in miniature, carried the art of painting on enamel to a degree of perfection never before attained. He resided long in England; and French writers affirm that he obtained the knowledge of the most beautiful and durable colours for enamel painting from Sir Theodore Mayence, at London, an eminent physician and chemist, who generously communicated his secrets to him, and recommended him to Charles I. After the king's death Petitot went to Paris, where he was highly favoured by Louis XIV., and gained a large fortune. Consequent on the revocation of the edict of Nantes he withdrew to Geneva.

Mr. Digby Wyatt, in a paper read before the Society of Arts, has traced the progress of artistic enamelling, from the time when it was merely a kind of mosaic work, down to recent days, when the resources of the painter are brought to bear upon it. He traces six stages or leading varieties, succeeding each other in a definite order; they were marked by attempts either to improve the fixature of the vitreous paste on its metallic base, or to increase the external adornment. The first, or *Byzantine* style, was practised throughout the Eastern empire from the time of Justinian down to about the year 1300. The best known works of this kind were executed by Theophilus, the celebrated artist-monk of the 11th or 12th century. The chief peculiarity of the process was in the formation of cavities or cells of gold filagree, for the reception of the enamel. The second, or *Early Limoges* style, was much practised in that city from the 11th to the 14th centuries; it consisted in forming incisions in a thick copper plate by the graver, for the reception of the enamel, in substitution of the Byzantine or filagree method. The third, or *Early Italian* style, was practised from about the close of the 13th century to that of the 16th. The most celebrated artist in this method was Ugolino Veri, who executed the shrine in the Orvieto Cathedral in 1338; but it was afterwards much practised by goldsmiths and enamellers. It appears to have occupied a midway position between the ancient *champ levé*, or incised enamel, and the painted enamels afterwards produced; it consisted in engraving on silver after the manner of medallic relief, and then floating it over with variously coloured transparent pastes. The fourth, or *Jeweller's* style, was either actually invented by Benvenuto Cellini, or he at least was the first to describe the improvement that took place in the enamelling art about the beginning of the 16th century. This method consisted in the use of a particular vehicle or liquid with the glass powder employed to cover small gold or silver objects in the round or in very high relief; the vehicle consisted of water in which the pips of pears had been steeped; the paste was held in its place until vitrification took place, and was yet so delicate a cement as in no degree to interfere with the perfect purity of the enamel. The fifth, or *Late Limoges* style, sprang at once from the inventive genius of Leonard Limousin, under the auspices of Francis I. It differed from the preceding styles chiefly in this: that the surface of the metal was entirely covered with an opaque paste, on which paintings were executed in transparent colours; the effect of a translucent ground was then obtained by applying silver leaf in particular situations, fixing it with a glaze of coloured enamel, and finally tinting over it. In the hands of a true artist, this method was susceptible of beautiful results; but it degenerated into tawdriness under the Nouailhers, a family of enamellers who lived during the latter part of the 17th century. The sixth, or *Miniature* style, was that which Petitot, the enameller mentioned in the last paragraph, was the first to bring to a high state of excellence. The chief characteristics of this style were, a great enrichment by the addition of new pigments, a power of multiplying the number of firings, a more minute graduation of tints, and an increasing modification in hardness and fusibility by means of fluxes. This, in the present day, is the chief kind of enamel-work, considered as a branch of the fine arts.

The painting on enamel is in itself virtually enamelling; for the pigment employed is an enamel, or glass, or vitrifiable substance, coloured with various metallic oxides, chlorides, and salts (no vegetable or animal colours being employed). The coloured pieces of enamel are ground up very finely in an agate mortar with oil of lavender, or some other liquid; and the paint thus prepared is laid on with a fine camel-hair pencil. The heat of an oven is finally employed to fuse it, and the enamel-paint becomes firmly incorporated with the enamel-ground.

The difficulty of preparing the plates for enamel painting, and more especially the care and caution required in burning in the colours, with the very great risk attending the operation, had, till recent times, restricted the ordinary size of fluxed plates, and consequently of enamel paintings, to five or six inches; and French writers think it would be little short of madness to attempt such works on a larger scale. But English artists have of late years so far exceeded these limits, that it would be absurd to hazard any dogmatic opinion respecting the possible extent to which they may go. The late Mr. Horace Hone was, we believe, the first who ventured much to exceed the usual size; he produced a beautiful whole length portrait of a lady, which was about twelve inches high, and broad in proportion. But this was far exceeded by the late Mr. H. Bone, whose copy from the famous picture of Bacchus and Ariadne by Titian, in the National Gallery, measures 18 inches by 16½. Mr. Bowles became the purchaser of this enamel for the enormous sum of 2200 guineas. His son, Mr. H. P. Bone, had in the exhibition of the Royal Academy, in 1837, a copy of the Virgin and Child, by Vandyke, also of large dimensions. Mr. Charles Muss produced a copy in enamel of a Holy Family after Parmigiano, measuring 20½ inches by 15¼; George IV. purchased this for 1500 guineas.

When we contemplate such works finished in the most exquisite manner, we cannot but admire the courage of the artist in undertaking them. The brilliancy and permanency of the colours are indeed a great temptation and an ample reward for success. But chances of failure are great, and increase with the size of the work, which is not safe till it has undergone the operation of being exposed to the fire for the last time. Indeed the whole process from the very outset requires in every stage the utmost care and attention, and a degree of skill in the management which only long practice can give. No fault in the design can be corrected; the artist's conception must be traced in the first instance with perfect accuracy; the fire may destroy the work, but what it fixes, whether good or bad, is unalterable.

3. *Enamelled Ware.*—A process is now extensively practised of enamelling the interior of cast-iron and other hollow articles, such as saucepans and other culinary and domestic utensils. The superior cleanliness of such articles, and the security which they afford against any metallic taint, render them peculiarly valuable for some delicate operations in cookery and confectionary, and for the preparing of pharmaceutical decoctions, extracts, &c. A patent was obtained in 1799 for two modes of performing this process, by Dr. Hickling; but though the manufacture of enamelled wares was carried on for some time under this patent, it was at length given up, for want of due encouragement. A second process was patented by Messrs. Thomas and Charles Clarke, in 1839, for applying an enamel lining less liable to crack or split off with the action of fire than that commonly used. According to their specification the vessels are to be first thoroughly cleansed by exposing them for three or four hours to the action of dilute sulphuric acid, and then boiling them for a short time in pure water. The first enamel composition is then applied. It consists of 100 lbs. of calcined ground flints, and 50 lbs. of borax, also calcined, and finely ground with the flint; this mixture is fused and gradually cooled, after which it is ground in water with the addition of one-eighth of its weight of potter's clay, until the mixture forms a mass of a pasty consistence. This coat is set by placing the vessel in a warm room, after which, while it is yet moist, the second or glazing composition is sifted finely and evenly over it in the form of a dry powder. This glazing composition consists of 125 lbs. of white glass (without lead), 25 lbs. of borax, and 20 lbs. of soda (crystals), all pulverised together, vitrified by fusion, ground, cooled in water, and dried. To 45 lbs. of this mixture 1 lb. of soda [illegible] added; the whole being then mixed together in hot water, and when dry, pounded to prepare it for sifting on the vessel as above stated. The vessel is then dried in a stove at a temperature of 212° Fahr., and subsequently heated gradually in a kiln or muffle resembling that used for glazing china, until the glaze is fused or fluxed. Sometimes the glaze-powder is again dusted over the fused glaze, and fluxed a second time in the kiln. Some other manufacturers, having produced enamelled ware of excellent quality, were sued by the Messrs. Clarke for an invasion of their patent rights; but the patentees were non-suited in the Court of Exchequer. Indeed, the formulæ by which a good enamel may be compounded are almost innumerable, so that a patent for such a purpose seems to be untenable, or at least easily evaded. Many enamels used for this purpose possess deleterious properties, owing to the presence of lead, which was found in some of the earlier wares made under Clarke's patent, before the use of glass containing lead was avoided; but the best manufacturers now limit themselves to the employment of harmless ingredients.

However the process may be varied in detail, the general principle is always the same,—namely, that of applying a vitreous glaze, either transparent like glass or opaque like enamel, and either white or coloured, to the surface of a piece of metal very carefully cleansed and prepared, and afterwards uniting the two firmly by fusing the glaze in a kiln. The culinary and other vessels of enamelled ware are now becoming an important branch of manufacture at Birmingham and Wolverhampton. In the Official Report prepared by direction of the Board of Trade concerning manufactures in metal sent to the Paris Exhibition in 1855, the following observations occur: "In the more useful cast-iron articles, such as kitchen utensils, especially enamelled hollow ware, the exhibits of Austria and Prussia presented features which evidenced a great improvement during the last three or four years; but it is quite clear that exhibitors of these useful articles have been fully alive to the importance of improvement; and two leading representatives of this branch of industry, Messrs. Clarke of Wolverhampton and Messrs. Kenrick of West Bromwich, certainly more than sustained their position, not only by the character of the work, but also by the variety of the utensils to which they had succeeded in applying the process. The Birmingham productions of the Patent Enamel Company under Paris's patent were not represented in the Exposition. These consist of a great variety of utensils stamped in sheet iron for culinary and other purposes, the surfaces of which are covered both inside and outside with a glass enamel. Though originally a French invention, it is now likely to form an important feature in British manufactures, since it can be applied to many articles made in wrought iron which require to be protected from the atmosphere or the action of water. Plates, dishes, &c., produced by this process for table use are susceptible of any amount of decoration, in the manner and by the methods applicable to ordinary earthenware or porcelain, and are peculiarly suitable for ship purposes from their lightness and non-liability to fracture. In many decorative purposes this method of enamelling on sheet iron is likely, under proper direction, to become of great value and importance."

Enamelling hollow iron ware is the principal but not the only application of the art to useful purposes. The enamel for watch-dial faces, adverted to in an earlier paragraph, is often distinguished as *glass* enamel. It derives its whiteness, not from tin and antimony, like artists' enamel, but from arsenic; the substance thus produced is very glassy, brittle, easily scratched, readily fusible, and very white. It is not at all suited for coating culinary vessels, but renders excellent service for watch- and clock-dials, and ornaments for the mantel-piece or the toilet-table. In the enamelling of dials, the enamel is first broken into small pieces with a hammer, and then pounded with an agate pestle and mortar. A plate of copper is prepared of the proper size and shape; the enamel-powder is spread evenly upon it; the plate is exposed to heat, and the enamel adheres firmly to the metal. For the best kinds of dial-faces a second coating of enamel is laid over the first. The figures or numerals which belong to a watch or dial are painted with a vitrifiable colour, somewhat in the same way as artistic enamel-painting, after which the heat of a kiln, melting the colour and softening the enamel, incorporate the two into one body.

We may advert in this place, as belonging quite as much to the enamelling art as to that of earthenware or porcelain, to the Baron du Tremblay's *émail ombrant*, or *shaded enamel*, a production remarkable alike for the ingenious way in which it is wrought and for the pleasing appearance which it is said to present. It consists in flooding coloured but transparent glazes over designs stamped in the body of earthenware. A plain surface is thus produced, in which the cavities of the stamped design appear as shadows of various depths, the parts in highest relief coming nearest the surface of the glaze, and thus leaving the effect of the lights of the picture. If taste be exercised in the selection of the design, this art appears to be susceptible of many beautiful modifications.

ENCAMPMENT is the lodgment or station of an army, with its artillery, baggage, and stores, when it has taken the field for the purpose of a review, or of acting against an enemy.

Under the word CAMP (ROMAN) there has been given an account of the ancient castrametation; and, till the employment of fire-arms in war, it is probable that the manner of occupying ground for military purposes which had been adopted by the Romans continued to be used by the nations formed on the ruins of their empire, such alterations only being made in the internal arrangements of the camp as were rendered necessary by differences in the numerical strength of the principal divisions of the troops.

The camps of the Britons, and those of the Anglo-Saxons and Danes in this country, seem to have been intrenched by breast-works made of felled trees, or of earth and stones rudely heaped together. Concerning the disposition of the troops within the inclosure, we only know that the Saxons drew up their cavalry in one dense body surrounding the standard, and that they placed the foot soldiers with their heavy battle-axes in front. In a description of the camp formed by Edward II. during his expedition to Scotland in 1301, is contained the first hint we have of any regularity in the distribution of an English army while in the field; this amounts however to little more than that the ground was marked out, and that to every one his proportion of the space was assigned. Within the spaces tents of white or coloured linen were set up, and huts were constructed, the latter probably for the private soldiers. (Grose, 'Mil. Antiq.,' vol. ii., p. 205.)

In former times both the English and French commanders of armies appear to have fortified their encampments when they undertook the siege of any place, particularly if it appeared likely to be of long duration; and P. Daniel states, that when cannon were used, it was placed for the protection of the army in large redoubts of wood or earth, called *Bastilles*, constructed at intervals along the circumvallation. The same author relates that the English, while they made war in France, went by parties into the country, carrying with them strong pallisades to form an intrenchment, behind which they were protected while using their cross-bows. ('Hist. de la Milice Françoise,' liv. vii., ch. 2.)

In the modern system of war, from the necessity of avoiding as much as possible the destructive effects of the enemy's artillery, and the desire of affording all possible development to the fire of their own infantry, commanders of armies have been compelled to abandon the square form of the ancient encampments, and to adopt that of long and narrow lines. But with this arrangement it seldom happens that the ground will permit a perfect regularity in the dispositions of the several battalions and squadrons; and the occurrence of streams or other accidents of the country may break the continuity of the line, or may render it necessary to give it a bent or waving direction. When, however, an army is encamped under tents, it may be regarded as a general rule that the line should correspond to that in which the troops are to be drawn up to engage the enemy; also that the tents of each battalion should not occupy a greater space in front than the battalion itself would cover when in order of battle,—a practice which is said to have originated with Gustavus Adolphus.

The length of the front of a battalion of 750 men, two deep, allowing 21 inches to each file, will be 219 yards; and this would be the extent of the line of tents, were it not that the line is regulated by the probable number of effectives, instead of the numerical strength of the establishment. The depth of the encampment for a battalion is of less importance; but, when the ground will permit, it may be regulated by the following disposition, which is considered to afford sufficient convenience.

The tents of the privates may be ranged in two lines parallel to the front, with an interval of about 12 feet as a street between every two companies in each line, and those of the captains and subalterns may be in one line in the rear of these; the field-officers and the commanding officer may occupy a fourth line; the staff a fifth; and the line of kitchens may be in the rear of all. By this arrangement the depth, including a space for the sutler's tent, the bâtmen and horses, will be about 90 yards; but an interval of 16 yards should separate the front of the men's tents from the line of parade, which is parallel to that front. Opposite the centre of the battalion, and about 60 yards in front of the line of parade, are the tents of the party which forms what is called the quarter-guard; and at about 15 yards in rear of the kitchens the party forming the rear-guard is situated. Including all these intervals, the depth of the encampment for infantry will be 183 yards.

The length of front for a complete regiment of cavalry, consisting of eight troops, when formed two deep, is about 320 yards; and this may be considered as the extent occupied by the regiment in the line of the encampment. The seven tents of each troop are ranged in a line perpendicular to the front, and the horses are attached to pickets in lines parallel to those of the tents; the remainder of the space, reckoned parallel to the front, being occupied by the breadths of the streets. In rear of the men's tents, and parallel to the front, are arranged the subalterns' horses in one line; the tents of the captains and subalterns in another; those of the field-officers and commanding officer in a third, and the kitchens in the rear of all. The standards are placed parallel to the front at 10 yards before the tents of the privates; and the distance from thence to the line of parade is 30 yards: with these dispositions the whole depth of a regiment of cavalry will be 216 yards.

A large army is encamped in two lines which, if the ground will permit it, are parallel to, and at the distance of about 300 yards from each other; and a reserve, generally consisting of the best troops, is formed in rear of the second. The stations of the cavalry are on the flanks of each line. The artillery attached to an army is formed into brigades, and is posted either on the flanks of the camp or with the reserve in the rear; the extent of front, for a heavy brigade, is 69 yards, and the depth, including the line of guns, of limbers, and three lines of waggons, is 82 yards.

The circular tents at present in use are 13 feet 8 inches diameter within the walls (the canvas which hangs vertically between the conical part of the tent and the ground). Of the cavalry 12 men, and of the infantry 15 men, are appointed to each tent.

From a document which is supposed to be of the time of Elizabeth, it appears that then an English camp was divided into six portions, of which three were assigned to the cavalry and three to the foot soldiers; and that between every division was a street 80 feet wide. There was also a space allotted for the market, and within this was the park of artillery, surrounded by carriages. It was regulated that no man should pitch his tent within 140 feet of the ring, or periphery of the camp.

The soldiers' huts or tents were placed 25 deep; each was eight feet square, and contained two men; the depth of the encampment, including the depôts, the officers' tents, and the cross streets, was 300 feet; and, including the streets, the whole extent in front of a regiment consisting of 13 companies, each of 150 men, was 712 feet. Originally, it seems, the officers' tents were placed in front of those occupied by the men; but Sir James Turner states that Henry of Nassau changed that custom, and caused them to be placed in the rear, as they are at present, in order that the soldiers might be enabled to have more easy access to the parade in front of the line. (Grose, ii. pp. 213, 214.)

The great extent of the space which, for the reasons before mentioned, is unavoidably occupied by an army in the field, renders it, in most cases, impossible to fortify the site of the encampment by a continuous line of parapet like that with which the Roman armies surrounded themselves on taking up a defensive position; and the security of a modern army against surprises is now obtained principally by the situation being difficult of access, from streams, marshes, or inequalities of the ground, and by keeping numerous advanced posts to watch all the approaches by which an enemy might arrive at the camp.

There are, however, some circumstances which render it indispensable that an encampment should be strengthened by fortifications; as when the troops are inexperienced or the army is deficient in cavalry; but chiefly when a position is occupied which it is of the utmost importance to hold, because the possession of it would be advantageous to the enemy. The latter may then be reduced to the alternative of attacking the encampment at a disadvantage, or of suffering a loss of valuable time in making the movements necessary to turn it. In these cases, every resource of the engineer in the construction of works and in obstructing the approaches should be put in practice for the purpose of augmenting the resistance which the army may be capable of making.

A continuous line of works may therefore be admissible for an army inferior to that of the enemy, provided the extent of the line be not so great as to prevent the intrenchments from being sufficiently manned in every part; but a camp so fortified would possess no advantages for an army which is strong enough to assume the offensive on a favourable occasion presenting itself; and it is evident that, in this case, it would be sufficient to construct merely a few redoubts in situations from whence a fire of artillery might be directed for the purpose of defending the approaches, while the disposable force of the army might be kept in masses ready, at a proper time, to make a movement to the front through the intervals between the works.

This principle does not, till lately, appear to have been well understood; and the cautious spirit with which a campaign was conducted during the 18th century contrasts strongly with the bold measures generally pursued in the wars of Napoleon. Marshal Daun, though always superior in number to the Prussians, intrenched himself with the utmost anxiety; and in 1759, when he took up a position near Dresden, though the King of Prussia had lost the battle of Kunersdorf, and the Austrian army was encamped upon steep rocks, covered by a stream difficult to pass, yet the marshal surrounded himself with works so numerous, that even the smallest paths were protected by them, and so strong, that twenty years afterwards they were in existence. But one of the most celebrated of these intrenched camps was that which, in 1761, the King of Prussia took up at Buntzelwitz, in order to cover Breslau. This camp was formed within a chain of hills protected on three sides by streams: six salient points on the contour were fortified by bastions, the fires from which would have flanked the intermediate parts of the line, and these were further protected by *flèches*, constituting a sort of broken curtain between every two redoubts. Nearly 180 pieces of artillery were planted to defend the avenues, and the camp was surrounded by abatis and other obstacles by which the approach of an enemy might be impeded. (Jomini, 'Traité des Grandes Operations Militaires,' tom. iv.) Such intrenchments, however, avail nothing when the army is not commanded by a man of great military genius. The French camp at Malplaquet, in 1709, is stated to have been fortified with a triple line, consisting of breastworks, hedges, and felled trees; it was forced, however, though with great loss, by the allies under the Duke of Marlborough.

It is remarkable that, during the war in Spain, which in general was distinguished by inattention to the means of strengthening the positions occupied by the troops, one of the finest examples of an intrenched camp was afforded in that which the British army occupied before Lisbon in 1810. This consisted of a double line of detached redoubts constructed on all the commanding points of ground, for the purpose of defending the four great roads and the accessible passes by which the enemy could approach to that city. The first line began at the mouth of the Zizandra on the Atlantic; it crowned the heights above Torres Vedras, and following the chain of Monte Graça, extended to the Tagus at Alhandra, its whole length being about 29 miles. The second was about six miles in the rear of the first; it began at the mouth of the S. Lorenzo, on the ocean, passed over the heights at Mafra, Montechique, and Bucellas, and reached the Tagus, at Quintella, its whole extent, in length, being about 24 miles. The weakest part seems to have been the valley of Calhandria, near the Tagus, on the exterior line; but this part was afterwards strengthened by a double row of abatis, besides breast-works of earth and thick stone walls. When the lines were completed, they consisted of 152 redoubts, armed, in all, with 534 pieces of ordnance, and required above 34,000 men for their garrisons. The disbursements for their construction amounted to nearly 100,000*l*. (Colonel Jones, 'Memoranda on the Lines about Lisbon,' p. 107.) [LINES OF INTRENCHMENT; MILITARY POSITIONS.]

ENCAUSTIC PAINTING (ἐγκαυστικὴ, encaústike) is a kind of painting much in vogue among the ancients, in which by heating or burning in (as the Greek term implies), the colours were rendered permanent in all their original splendour. In speaking of encaustic painting, the use of wax as a vehicle is usually understood, though it is not implied in the term. Encaustic painting with wax and naphtha as vehicles was practised among the Egyptians, but as Sir Gardner Wilkinson observes ('Anc. Egyptians,' iii. 312), "the time when it was first known there is uncertain, nor can we conclude from a specimen of Greek time that the same was practised in the Pharaonic age." Among the Greeks it was practised from a very early period, but there has been much discussion among the learned as to the methods employed and the materials used by them. Pliny, in his 'Natural History' (xxxv. 39), gives a short account of the invention and nature of this art. He says, "Ceris pingere ac picturam inurere, quis primus excogitaverit non constat." But though he expressly says wax, some persons have imagined that by *ceris* he here means some composition different from wax, and capable of bearing the fire, and that *inurere* means to enamel. In a succeeding chapter (41) he says that there were anciently two modes of encaustic painting, "cera et in ebore, cestro, id est, viriculo, donec classes pingi coepere. Hoc tertium accessit, resolutis igni ceris, penecillo utendi." The two ancient kinds, "with wax and on ivory," seem to have been both executed by means of a "cestrum, that is, a graver." The use of a brush in encaustic painting was not introduced till ships began to be painted, "the wax being melted by fire." It has been found extremely difficult to explain these three processes in a satisfactory manner. Of the two most ancient kinds, the first appears to have resembled painting, at least in its results; the second to have been either merely applying on a small scale and in a more careful manner the coarser mode of encaustic painting on wood, or else what Sir Charles Eastlake describes as ('Materials for a Hist. of Painting in Oil,' p. 151) "a sort of intaglio filled in with tints." The third kind, with a brush, and melting the wax by fire, continued in use almost or quite to the revival of painting in the 15th century.

The Marchese Haus ('Pittura all' Encausto'), assuming, with Pliny, three kinds of encaustic painting, distinguishes as an essential point, whether the cestrum (style, or graving tool) or the pencil was employed in the execution. In the first mode, the wax was, he supposes, melted, mixed with as much earth colour finely powdered as it could imbibe, and then this was spread on wood, or on a wall, with a hot spatula. When it became cold, it was the ground, in which the designer cut the lines with a cold pointed tool (style, cestrum), and thus, properly speaking, it was not the painting but the wax ground that was burnt in, and the name encaustic was improperly given to the painting. But a more probable explanation is, that by means of a style the colours prepared with wax were laid on to the prepared ground of the panel, and then toned down and blended by a hot iron, the flat end of the cestrum being probably used for the purpose. But the final burning in, or inustion, as it is technically called, appears to have been an essential part of the process.

With regard to the second kind, encaustic painting on ivory, Professor Grund, of Florence, who has devoted much attention to encaustic painting, suggests ('Die Malerey der Griechen,' Dresden, 1811) that when the practice of drawing on hard wax had been brought to some degree of perfection, they proceeded to apply it on a small scale to ivory, which was at that time in the highest estimation. Ivory tablets were therefore covered with red or black wax, and the design cut in it with the style, the object being to use the clear and smooth surface of the ivory for the lines, that they might look the more beautiful. This therefore was nothing more than applying to ivory what had previously been done on wood, or walls. But the probability seems much greater that this second mode was a species of intaglio: "The outlines first drawn on waxed ivory (for the facility of correcting them where necessary) were afterwards engraved in the substance; and the finished and shadowed design was filled in with one or more colours; being ultimate[illegible]overed with a wax varnish by the aid of heat. Works so produced must have resembled the *nielli*, or, on a small scale, the *sgraffiti* of the Italians, and were no doubt quite as excellent. . . . The heated instrument with which the wax tints were blended was called *rhabdion*: it was probably flat at one end (like the extremity of the stylus); its forms and sizes, indeed, may have been as varied as those of brushes now. The encaustic painter who used the rhabdion or cestrum (for the terms are employed sometimes indiscriminately) was provided with a box with compartments, in which the variously tinted cakes or sticks of wax colours were kept. The canterium was not necessary; the rhabdion, heated in a small furnace kept at hand, supplied its place." (Eastlake, pp. 149-54.)

The third kind is the applying the colours with the brush or pencil. With respect to the manner in which this was executed, opinions again differ. The received notion seems to be that the wax was dissolved, the colours mixed with it, and laid on with the pencil, and the painting then finished by careful approximation to the fire whence this kind of painting became properly encaustic. For this purpose a hot iron, or a pan of coals (cauterium) was used. The painting was commonly executed on wood, but also on walls. The point on which there has been most difference of opinion among later writers who have treated of this third mode is, as to the means adopted for mixing the wax with the colours so as to allow of their being used with a brush. The modes suggested are resolvable into three: "1. The solution of wax by a lixivium, or in more general terms, by any means which will allow of the pigment being mixed with water. 2. The solution by means of heat in a fixed oil. 3. The solution by means of an essential oil." (Eastlake.) For all of these, certain authorities may be cited, but the last is that which on the whole appears to be the most feasible; and it accords most with modern practice and chemical analysis. Wilkinson, we have seen, states that in the encaustic painting of the ancient Egyptians wax and naphtha were found.

When painting had been greatly improved by the invention of the pencil, a new method of encaustic was attempted. Encaustic wax painting had hitherto been designing on a coloured ground: it now became painting with wax colours burnt in. When the artist had laid on the wax ground, and traced the outlines with the style, he proceeded to the colouring. From the wax mixed with the colours he separated with the hot style as much as he wanted to cover a certain space, and spread it over the ground, put a second, third, &c., colour next the first, so that he had local tint, half tint, and shade together, which he softened into each other with the hot style.

Encaustic painting did not come into use among the Greeks until after the time of Alexander, when the arts were beginning to decline. The works of all the greatest painters had been executed in tempera, and tempera painting therefore continued to be regarded as the higher branch of the art. For small works, however, encaustic was regarded as the superior method, and the small painted tablets of Pausias, and the portraits of the female painter Lala, of Cyzicum, were held in great estimation. But large pictures were also produced in encaustic, in Greece; and ceilings and walls were painted in encaustic. Among the Romans, encaustic painting, or at any rate painting with wax colours, was so general that ceræ came to be an ordinary term for painters' colours. Encaustic painting continued to be practised during the early centuries of Christianity, both in the Eastern and Western empire, almost to the exclusion of every other mode except mosaic; but eventually this last seems almost to have superseded it. Encaustic was not wholly abandoned, however, as late as the 14th century, though references to it in that and the previous centuries are extremely rare. Before its final extinction the practice of using a wax varnish with a final inustion appears to have been more prevalent than that of encaustic painting proper.

After the whole art of encaustic painting had long been lost, the memory of it was recovered by Count Caylus, in France, who announced to the Academy of Painting the method of painting in wax in 1752: a Mr. Bachelier however had actually painted a picture in wax in 1749, and is the author of a treatise on the art and secret of wax painting; and he was the first who communicated to the public the method of performing the operation of inustion, which chiefly characterises encaustic painting. The count kept his method secret for a time, and in 1754, exhibited at the Louvre a head of Minerva painted in the manner of the ancients. This was much admired, and it was affirmed that in wax painting the colours were more permanent, purer, and brighter than in oil painting: an account of his procedure was published in the 'Encyclopédie,' art. Encaustique. Several other persons made essays in this art, one of the most indefatigable being the Abate Vincenzo Requeno, who painted several works, and, in 1784, published a book on the subject, which was reprinted with additions at Parma, in 2 vols. 8vo. He was followed by painters and archæologists at Venice, Verona, Milan, and Rome, in each of which cities several works were executed in encaustic, and accounts of greater or less length and value published descriptive of the processes employed. After a time, the attempts proving unsatisfactory, the process fell into neglect, but some thirty years back it was again revived with considerable energy at Munich, under the patronage of the late king Ludwig, of Bavaria, and several public and private apartments were painted in it. The fashion spread to Berlin, Heidelberg, Vienna, and wherever the influence of the revived German school penetrated. It has also been followed to some extent in France; and many encaustic works have been executed of late years in various parts of Italy. The modes adopted by the painters of these countries have been very various, but in all wax has been the distinctive vehicle, and almost invariably the wax has been dissolved in turpentine or some other essential oil (at least for mural painting) and coarse mastic or other resin has been used for strengthening the vehicle with which the colours are laid on the wall. The final inustion is omitted in some of the processes. Notwithstanding the failure of many of the most promising works executed in it, the process has its admirers and advocates; and many still believe that, with some improvements in the methods hitherto adopted, it is capable of being rendered the most permanent, as well as the most brilliant, style of painting. But it is, perhaps, more fitted for decorative work than for painting of a higher order. The complexities of the manipulation must cramp the hand of the painter, and the firmness, decision, and sharpness of touch—that individuality of handling in fact—which are so great a charm in the work of a great painter, can hardly be attainable in a process the last stage of which removes all traces of the pencil. For decoration this artistic individuality is less required, and the warmth and glow of the colours, the shining surface, as well as the facility with which it can be cleaned, are greatly in its favour. The fullest account of the modern process, and that which judiciously carried out promises to be most successful, is that of M. J. P. de Montabert, 'Traité Complet de la Peinture,' vol. viii. p. 526, &c. The work of Sir C. L. Eastlake, quoted above, should also be referred to; and much of value on the history of the art, and on the ancient and modern processes, will be found in the following works, which, with those given above, will supply ample references if it be desired to carry the inquiry farther: Millin, 'Dictionnaire des Beaux Arts' (art. Encaustique); Durosiez, 'Manuel du Peintre à la Cire' (Par. 1844); Raoul Rochette, 'Peinture Inédites' (Par. 1836); Letronne, 'Lettres d'un Antiquaire à un Artiste' (Par. 1840); John, 'Die Malerei der Alten' (Berlin, 1836); Wiegmann, 'Die Malerei der Alten;' Müller, 'Archäologie der Kunst,' § 320; and Reports of Commissioners of Fine Arts.

ENCAUSTIC TILES AND PAVEMENTS. [Tiles and Pavements.]

ENCEINTE is the term applied in fortification to the works of the *body of the place;* or the first belt, or line of ramparts (generally continuous), which surround the place.

ENCKE'S COMET. [Comets.]

ENCYCLOPÆDIA; ENCYCLOPÉDIE. [Dictionary.]

ENDECAGON, a figure of eleven sides.

ENDEMIC (*ἔνδημος, endémus,* from *ἐν,* in or among; and *δῆμος,* people, that which is among a people). By this word are expressed those peculiar forms of disease which arise spontaneously, as it is termed, in a country or in particular localities, and which are ordinarily produced by the peculiar climate, soil, air, water, &c. Thus, ague is the endemic disease of marshy countries or localities; the swelled throat or bronchocele is endemic in the Alps, and the plica in Poland. The word bears pretty much the same signification in relation to the diseases of a country that the term indigenous does to its plants. It is used in contradistinction to *epidemic.* [Epidemic.]

ENDOCARDITIS. [Heart, Diseases of.]

ENDORSEMENT. [Bill of Exchange.]

ENDOSMOSE is the attraction through an animal or vegetable membrane of thin fluid by a denser fluid. M. Dutrochet found that if he filled the swimming bladder of a carp with thin mucilage and placed it in water, the bladder gained weight by attracting water through its sides: to this phenomenon he gave the name of *Endosmose* (from *ἔνδον* and *ὠσμος*). He also found that if he filled the same bladder with water and placed it in thin mucilage, it lost weight, its contents being partially attracted through its sides into the surrounding mucilage; this counter phenomenon he named *Exosmose* (from *ἐξ* and *ὠσμος*). The same circumstances were seen to occur in the transmission of fluids through the tissue of plants; it was found possible to gorge parts of vegetables with fluid by merely placing them in water, and to empty them again by rendering the fluid in which they were placed more dense than that which they contained. It was also ascertained that this phenomenon took place with considerable force: Dutrochet says that water thickened with sugar in the proportion of 1 part sugar to 2 parts water, was productive of a power of endosmose capable of sustaining a column of mercury of 127 inches, or the weight of 4½ atmospheres.

This phenomenon is by its discoverer considered sufficient to explain many of the movements of the fluids both of plants and animals; his first book upon the subject is entitled 'L'Agent immédiat du Mouvement Vital, dévoilé dans sa nature et dans son mode d'action chez les Végétaux et chez les Animaux,' Paris, 1826, and in his numerous more recent writings he sustains the same opinion. To the effects of endosmose he refers the motion of sap; the sleep of leaves; the various directions taken by plants under the influence of external agents, such as turning to the light or away from it; many kinds of irritability; the attraction of fluids to particular points, and the like. That Dutrochet's arguments are extremely ingenious, and his observations highly curious, no one will deny; but we agree with De Candolle, that, supposing this celebrated physiologist's views to be correct, we must still have recourse to vital force as the great and inexplicable cause of all such phenomena. When organic tissue dies, it does not lose its mere hygrometrical powers, nor do its tubes cease to exert their capillarity, but no more vital movement of fluids takes place; yet mere endosmose will take effect through dead membranes, as is proved by the instrument called an *endosmometer.* [Osmometer.] We can only then allow endosmose to be one of the powers which, in combination with vital force, assist in producing some of the phenomena of life.

Dutrochet considers endosmose to be owing to what he calls *intercapillary electricity,* grounding his opinion partly upon the experiment of Porret, who found that when two liquids of different levels are separated by a membrane, they may be brought to a level by establishing an electrical current between the two, thus rendering the membrane permeable; and partly upon experiments of his own. But M. Poisson, on the contrary, has demonstrated that endosmose may be the result of capillary attraction joined to differences in the affinity of heterogeneous substances. ('Ann. de Chim.,' vol. 35, p. 98.)

The more recent development of this subject will be given under Osmose, to which we referred under Capillary Attraction; but we may here remark, that the phenomena of endosmosis and exosmosis, are intimately connected with the process of liquid diffusion. [Diffusion.]

ENDOWMENT. [Dower; Vicarage.]

ENEMATA. [Clysters.]

ENFEOFFMENT. [Feoffment.]

ENFILADE is the term applied to a fire of artillery or musketry when made in the direction of the length of an enemy's line of troops, or when made from any battery to the interior of an enemy's rampart or trench in the direction of its length. When an artillery fire is so employed by the besiegers of a fortress, the intention is to dismount the guns of the defenders; and this end it accomplishes with more certainty than if the fire were directed from the front towards the mouths of the embrasures, both because the side of a gun-carriage presents a larger surface than the muzzle of the piece to the action of the shot, and because the same shot may take effect against two or more guns placed upon the same line of rampart, or sweeping along the whole length of parapet, though missing one gun may take effect on another. An enfilading fire of artillery is also used by the besiegers to destroy the palisades or other obstacles behind a glacis, and to prevent the defenders from remaining at their parapets. When employed by the defenders of a fortress, it is intended to sweep any of the besiegers' trenches which may from necessity, or through the fault of the engineer, lie in a direction tending towards some part of the ramparts of the fortress.

The destructive effects of an enfilading fire, when directed against the guns on a rampart, are diminished by constructing traverses across the rampart at intervals, or by placing the guns in blindages. And, to avoid such fire in the trenches of the besiegers, the practice is to form those trenches in zig-zag directions, tending alternately to the right and left of the general line of the approaches, so that, if produced, they may fall on the exterior of all the ramparts from whence a fire might be directed towards the approaches: when this is not possible it becomes necessary to raise traverses in such trenches as are thus exposed to the fire.

In Sir John T. Jones's Journals of the Sieges in Spain, there is given an account of the ingenious attempt made by a French corporal to cause one of the trenches of the besiegers before Badajos to be enfiladed by the guns of the fortress: the man contrived secretly in the evening to displace on the ground the tracing cord which the British engineer had stretched in order to indicate the intended direction of the trench; and the attempt only failed because the officer who came on duty for the night accidentally discovered, before darkness came on, the error in the position of the line. [Ricochet.]

ENFRANCHISEMENT. [Copyhold.]

ENGINEERING (from the French word *ingénieur*) is properly the art of constructing and using engines or machines; but the term is also applied to that of executing such works as are the objects of civil and military architecture, in which machinery is in general extensively employed.

A distinction has long been made between the civil and military engineer; and since everything relating to the service of artillery is now confided to a particular corps, the duty of the military engineer may be said to comprehend the construction of fortifications, both permanent and temporary, including the trenches and batteries required in besieging places; also of barracks, magazines, and other works connected with warlike affairs.

Of the military engineer it may be said that a greater knowledge of the more minute details of construction is required than would suffice in the civil practitioner; because it may happen that the former is called upon to exercise his profession in some colony where workmen adequately skilled in the mechanical operations may be wanting. The accomplishment of the work may then become impossible, should the officer not be qualified to give the necessary instructions to those who are placed under his direction.

ENGINEERING, CIVIL, comprehends the designing and execution of every great work by which commerce and the practice of the useful arts may be facilitated, provided it be not of an artistic or ornamental character. Thus, in creating or improving the communications of a country, the civil engineer would be called upon to form a road through hills or over valleys or rivers, or to excavate a canal in connection with the waters by which it may be supplied, and to build the locks for retaining the surface of the water at different levels, in different places, when the inequalities of the ground are considerable. He raises embankments to resist the encroachments of the sea or to reclaim the land which it may have covered, and breakwaters to break the force of the waves at the mouths of natural harbours. He renders rivers navigable when their course is obstructed by rocks or banks; he forms docks or artificial harbours where ships may remain in security: he executes the works required for the water supply, the draining and lighting of towns, or the drainage and irrigation of the country districts, and he is required to penetrate by mines to vast depths for the purpose of seeking the mineral treasures contained within the bosom of the earth. Such are the occupations of this important class of men; and it is necessary to observe that they frequently, in addition, practise the avocation of the machinist in executing the presses, mills, looms, and other great machines employed in the arts and manufactures; and particularly in constructing steam engines and the apparatus by which they are rendered available for giving motion to ships, carriages, or machinery.

In France the title of engineer is extended to persons who are employed for the public service in trigonometrical surveying in the interior of a country or on the coasts, and in the practice of naval architecture. The French have thus a corps of ingénieurs géographes, of ingénieurs d'hydrographie, and of ingénieurs de marine.

Engineering must have originated with the first application of a lever for the purpose of moving a mass of any material which exerted a resistance exceeding the unassisted strength of man: by observing the effects produced in operations of that nature, the laws of the action of bodies on one another were gradually discovered, and mechanics, the science of the engineer, arose.

Archimedes, in addition to the title of geometer, may with justice claim that of mechanician and engineer; and in fact he is the first person who is known to have applied himsef to the cultivation of the mixed mathematical sciences. Besides demonstrating the fundamental property of the lever, he determined the centre of gravity in bodies of certain forms, and the positions in which bodies remain in equilibrio in a fluid; and from the celebrity he acquired among the ancients by the mechanical contrivances which, according to Polybius, he put in practice for the defence of Syracuse, we may conclude that if those contrivances were not his own inventions, they must have contained improvements upon such as had been in use before his time.

Vitruvius wrote his treatise on architecture during the reign, as it is generally believed, of Augustus. In that treatise he describes the manner of building the walls and towers for fortifying towns, the construction of temples, basilicas, theatres, and private dwellings; he describes the principal military engines which were then in use; he also gives some account of machines for drawing and raising weights, of engines for raising water, and of mills turned by water for grinding corn. The work may therefore be considered as comprehending every important object connected with engineering at the time in which he lived. Now he states, in the proem to the first book, that he had been appointed by the emperor to have the charge of the warlike engines; and in another place, that he had designed and executed a basilica at Fanum; it is evident therefore that he united in his person the character of engineer and architect; and among the ancients the profession of the former seems to have been generally included in that of the latter. The 'machinarius' was probably the artificer, or the officer who superintended the civil and military machines at the siege of a fortress.

Of the national works executed by the ancients, and which are to be considered as properly falling within the province of the engineer, some of the first of which we have any intimation are the sewerage of Nimroud lately discovered by Messrs. Botta and Flandin; and the canal uniting the Red Sea and the Nile, which, according to Pliny, was begun by Sesostris, or, according to Herodotus, by Necos, the son of Psammetichus, and finished by Darius the First. The canal of Xerxes across the isthmus of the peninsula of Athos is another example of works of this kind. The introduction of arches in works of magnitude may be said to have constituted an epoch in the profession of the architectural engineer, as the idea of giving to blocks of stone a form which would enable them to sustain themselves in balanced rest by their mutual pressures, the discovery of the means of arranging them on a curve surface, and the determination of the magnitudes of the piers or abutments so that the lateral pressure of the vault might be adequately resisted, imply a higher degree of intellectual power than is exhibited in covering a space with a horizontal roof. The Cloaca Maxima at Rome is probably the most ancient example in Europe of this scientific construction; the dome of the Pantheon, and the various arches of the Thermæ and of other public buildings both at Rome and in the provinces, such as aqueducts, and bridges, attest the grandeur of the design, combined with purposes of public utility, which characterised the works of the engineers and architects who lived under the early emperors.

Vitruvius enumerates several Greeks who had written on machinery; but from his time to that in which Italy rose again to importance after the fall of the empire, little is known concerning the state of engineering in Europe. Subsequently to the last-mentioned epoch, Carden, Guido Ubaldi, Valerius, and Galileo, in that country, and Stevinus, Huygens, and Descartes, in the north, are distinguished as cultivators of theoretical mechanics. Galileo particularly deserves to be named for his discovery of the laws of motion, his application of the pendulum to the measurement of time, for his theory of projectiles, and his contributions to the science of hydraulics as applied to engineering. From that time almost every distinguished mathematician, both on the continent and in this country, has contributed to the advancement of the mechanical sciences.

Previous to the commencement of the 18th century the most celebrated practical engineers were Brunelleschi, who built the dome of St. Mary at Florence; Peruzzi, San Gallo, and Michel Angelo, who executed that of St. Peter at Rome; Leonardo da Vinci, who constructed the earliest canal-lock in Europe; San Michæli, the supposed inventor of the bastion system of fortification: and Sir Christopher Wren, the architect of St. Paul's Cathedral.

In Holland and in the north of Italy the necessity of securing the low grounds against the inundations of the seas and rivers, and of obtaining an inland navigation for the purposes of commerce, gave rise to the cultivation of that branch of engineering which relates to hydraulic constructions; and the invention of the lock for canals is sometimes said to have taken place in the latter country about the middle of the 13th century. Indeed we find the profession practised in those countries on an extensive scale when there was not a man in England capable of undertaking the formation of a canal to drain the ground. Before the reign of Charles I. it appears to have been the practice to send to Holland for an engineer when any work of that nature was to be undertaken.

But the extension of the manufactures of this country soon after that period, and the consequent augmentation both of its internal and foreign commerce, called forth all the energies of its inhabitants, who, at length, in the works performed for facilitating the means of communicating between one place and another, and in the practice of the useful arts, rose to an eminence which other nations have not been able to surpass. Among the former may be mentioned the numerous canals and railways which intersect the country; the majestic bridges executed in stone over the Thames; in cast-iron over the Avon, the Thames, &c.; and those on the suspension principle at the Menai and at Hammersmith. Among the men in this branch of engineering to whom the nation is indebted are Brindley, Smeaton, Jessop, Telford, the Rennies, the Brunels, and the Stephensons.

The invention of the steam-engine, or rather its improvements in 1769, opened a new field for the talent of the engineer in the numerous uses to which the machine became applicable. Before the time of Watt it had been employed only as a pump to raise water; but this mechanician, by converting the reciprocating motion of the beam into a rotatory motion, rendered it capable, not only of replacing with greatly augmented energy, the power of wind, water, or horses, in giving motion to machinery for the purposes required in the arts, but also of serving as a first mover for propelling vessels through water, or for drawing carriages over land.

The course of education by which a student may qualify himself to become an engineer, whether civil or military, must necessarily comprehend a greater extent both of the pure and physical sciences than would be required for a person who is to follow any other profession. It will be, perhaps for ever, a matter of question how much mathematics should enter into a school course of engineering, and there are, no doubt, some persons who contend that no more is required than would serve to compute the cost of materials and the wages of labour: this, and the observation of existing examples, being supposed by such persons to be sufficient to enable a man to enter upon the practice of the profession. It is not, however, with such a limited knowledge that an engineer can be qualified to design an important work, which it may be required to conduct under new and difficult circumstances. Mere science certainly cannot make a man an engineer; for analytical formulæ relating to mechanical equilibrium being necessarily founded on the erroneous assumption that materials are perfectly hard, perfectly smooth, &c., and that the actions of bodies on one another are subject to invariable laws, have no practical utility unless corrected by observation and experiment. On the other hand, mere diligence in observing the results of practical operations will never raise a man to proficiency in the art unless he be gifted with very extraordinary powers. A judicious combination of theory and practice is indispensable, and such a combination can only be made by a man in whom great natural talent is blended with all the aids that the sciences can afford.

Of the military engineer it may be said that a greater knowledge of the more minute and mechanical details of construction is required than would suffice for the civil practitioner; because it may happen that the former is called upon to exercise his profession in some colony where workmen adequately skilled in the mechanical operations may be wanting. The accomplishment of the work may then become impossible, should the officer not be qualified to give the necessary instructions to those who are placed under his direction.

The professions of an architect and of an engineer, as they are practised at present, may be said to coincide with one another to a certain extent. The members of both of them must be able to form a judgment of the quality of the ground in which the foundations of their buildings are to be laid; they must be acquainted with the capacities of different materials, wood, stone, and iron, for resisting the strains to which such materials may be exposed, so that sufficient strength may be obtained with a due attention to economy; and they must equally attend to the princples of equilibrium in their roofs, arches, and domes, arranging the beams, bars, or voussoirs so that they may remain at rest with as little strain as possible upon the connecting ties by which the joints are strengthened. But here the two professions diverge from one another; for whilst the engineer has to determine, by a process of levelling, the profile of the ground on perhaps an extensive line of country, for a road or a canal; or has to determine the forms and dimensions of his retaining walls, so that they may resist the pressure of earth or water against them; or, finally, to devise methods of rendering the action of his moving powers uniform, and of transmitting them through a train of machinery to the place where the effect is to be produced,—the architect is engaged in designing the external forms and internal arrangements of edifices, in which, whether intended as palaces or private dwellings, or as buildings consecrated to the service of religion or of the state, architectonic beauty must be combined with fitness for the purposes for which they are intended.

ENGLISH BLUE. [COPPER, CARBONATE OF.]

ENGLISH RED. [COLOURING MATTERS.]

ENGRAVING, the art of executing designs by incision upon plates of copper, steel, or other metal, or in relief upon wood, for the purpose of obtaining therefrom impressions or prints upon paper. Although, in this sense of the term, the art is only coeval with that of printing, it has been practised with a more limited object from the earliest periods on record, in a similar manner and with similar instruments to those used at the present time. Except incidentally, however, we shall confine our attention in the present article to incised engraving on metal plates. Engraving on wood; on gems; and of dies for coins and medals will be treated under separate articles. [WOOD ENGRAVING; CAMEO; INTAGLIO; COINS; DIE-SINKING; MEDALS.]

On referring to sacred history we find in the writings of Moses rather detailed accounts of the character of the engraved works executed in his time, and of the substances whereon they were wrought; nor are we left in ignorance even of the names of the practising artists among the Israelites. Thus from the book of Exodus we learn that when Moses had liberated the Jews from Egyptian bondage, he was commanded to "make a plate of pure gold, and grave upon it, like the engravings of a signet, holiness to the Lord." He was also commanded "to take two onyx stones, and grave on them the names of the children of Israel according to their birth, with the work of an engraver on stone, like the engravings of a signet." Both these passages distinctly imply the practice of gem and seal engraving, and also of engraving on metal plates, a knowledge of which, among other arts, was, without doubt, acquired by the Israelites during their captivity in Egypt; and specimens of the art as practised in that nation, perhaps at as early a period as that now under notice, still exist. In the book of Exodus also honourable mention is made of one Bezaleel, who appears to have united the callings of the engraver, the jeweller, and the lapidary; and it is said that he "was filled with wisdom of heart to work all manner of work with the graver, as well as to devise cunning works; to work in gold, and in silver, and in brass, and in cutting of stones to set them." "And it was put into his heart that both he and Aholiab might teach them that were filled with wisdom to work all manner of work of the engraver." These are selected from numerous other passages in Scripture as sufficiently attesting the practice of several branches of engraving at this early period: from the same source indeed we learn that some of them, as for example, the engraving of signets, was practised at a time anterior to that of Moses.

The hieroglyphics and other remains of Egyptian incised work are the most ancient examples of the art existing, and among the most ancient relics of early civilisation now extant. The British Museum is particularly rich in such specimens, some of which are engraved on metal, and have been chiefly found in the coffins or cases of mummies. These engravings of hieroglyphics on metal, as well as those on the ancient sarcophagi, are evidently executed with similar instruments to those now in use: some of the lines narrowing downwards have clearly been cut with the lozenge-shaped graver now chiefly used; but other lines, being of the same width through their whole depth, must have been produced with that species of graver called a scooper, still used for effecting broad incisions. Only a single step indeed was needed for the Egyptians to have made the discovery of engraving in the sense of the definition at the head of this article. They used colours for various purposes, and they made paper, but the idea of filling the incisions in their metal plates with colour and taking off an impression on paper never occurred to them; nor did it occur to any other people for more than 3000 years later. That only this single step was required has been shown by the fact of impressions being actually taken on paper from these Egyptian engravings: among others from one of the very oldest in the British Museum, a plate found in a mummy chest by Dr. Mead. Like the Egyptians, the ancient Assyrians engraved both on stone and metal; they even went so far as to take impressions from their incised slabs, but it was in clay instead of on paper, and simply in relief, and not by means of ink or any coloured vehicle.

From Herodotus (v. 49) we learn that one of the earliest uses to which engraving was applied among the Greeks was the delineation of maps on metal plates. He says that "Aristagoras appeared before the king of Sparta with a tablet of brass in his hand, on which was inscribed every part of the habitable world, the seas, and the rivers; and to this he pointed as he spoke of the several countries between the Ionian Sea and Susa." The date of this event was 500 B.C. The engraving of metals with incised patterns for ornamental purposes was also much practised by the Greeks. Among the Etruscans, incised work was much in vogue from a very remote period; and prints which have been taken from Etruscan mirrors, of which there are several in the British Museum, sufficiently attest the capacity of these early engravings to deliver impressions.

In the peninsula of India, also, the art of engraving on plates of copper appears to have been practised long before the Christian era. It would appear that it was there customary to ratify grants of land by deeds of transfer actually engraven on plates of copper, as we now write them on skins of parchment. A copy of one of these very interesting relics is given with an English translation by Mr. Wilkins, in the first volume of the 'Asiatic Researches,' page 123. It is in the Sanscrit language, and bears date twenty years before the birth of Christ. Engraving was probably practised by the Chinese at a still earlier period. It would, however, be idle to follow further among the ancients a process that may in fact be said to have prevailed in every country where civilisation had made any progress.

After the fall of the Roman empire incised engraving on metal plates continued to be pursued by Byzantine artists; and throughout the middle ages the art was practised in Italy, Germany, and other parts of Europe. Ecclesiastical instruments of various kinds, weapons, and articles of personal ornament and household use, of mediæval date with engraved designs, often of admirable execution, are found in almost every public museum, and in numerous private collections. The metal sepulchral slabs, or brasses as they are termed [BRASSES], of France and the Netherlands, and once so general in our own churches, were executed entirely with the graver, and in precisely the same manner that a copper-plate is now engraved which is intended to be printed from; but as they were commonly exposed to the feet of the congregation, the strokes were cut deep that they might endure the longer, and consequently very neat workmanship is not to be expected. Some of them, however, especially those of the 13th and 14th centuries, bear evidence of considerable ability in the workmen.

We now approach the period when the invention of *printing* gave to engraving a new direction, and produced an effect on the civilisation of the world as astonishing as it is incalculable. The chief obstacle to printing had already been removed by the manufacture of paper from linen rags, which had become generally known in Europe at the latter end of the 14th century. It must be remembered, as giving additional interest to this subject, that it is to a certain class of engravers that we are immediately indebted for the first printed books, which were actually impressed from engraved wooden tablets—a method which was afterwards improved by substituting movable metal types; and thus the arts of engraving and printing, at the same time that they constitute the sole means by which all kinds of knowledge may be extensively diffused, have placed it within the power of all to possess the thoughts of the best men in literature, science, and art.

The first prints, as we have already intimated, were obtained from engraved wood blocks. This might naturally be expected, because the process of printing from such works is so simple and obvious, not requiring even a press, that persons of reflection are astonished, not that printing was invented so soon, but that it had not been discovered sooner. To obtain impressions from the incised hollows of an engraved metal plate, on the contrary, is a much less obvious process, requiring the aid of a somewhat complicated machine, called a rolling-press. We need not wonder, therefore, that its discovery should have been later; and, indeed, the two processes are so very different, that when one was discovered it did not lead necessarily to the other.

The earliest print with a date attached to it is one known as the St. Christopher, which is from a wood block, and dated 1423; but no impression from an engraved *plate* has been found with a date for many years later. It has long been a disputed question whether the art of engraving on metal plates for taking impressions on paper originated in Italy or Germany. According to Vasari, it originated from a discovery made by Maso Finneguerra, a Florentine goldsmith and worker in niello, about the year 1450; and this is the view commonly adopted by English, though contested by German, writers. Be that as it may, there has never existed a doubt that the art had its origin in the workshops of the goldsmiths about the middle of the 15th century. Many of these goldsmiths were *niellatori*, or workers in *niello*,—a mode of ornamental engraving usually performed on silver plates, the design engraved on which was afterwards filled in with a black composition, which from its colour was called by the ancients *nigellum*, a word curtailed by the Italians into *niello*. [NIELLO.] This being run into the engraved lines, produced the effect of shadow, and had very much the appearance of a print. It was usual with the artists who worked in niello to ascertain the appearance of their work at different stages of its progress by taking casts in soft earth of the portions executed. Upon these casts they poured melted sulphur, and thus obtained a fac-simile of their engraving. Then, by rubbing a mixture of lamp-black and oil into the design on the sulphur, they were able to judge what would be the effect of the work previous to inlaying with the nigellum or mixture of silver and lead. According to Vasari and the Italian writers, it occurred to Finneguerra to try if the same result would follow on a piece of moistened paper if laid over the design thus filled with ink and pressed by a roller. The experiment succeeded; and the consequence was the gradual improvement of the new art both in his hands and those of Baccio Baldini, Sandro Botticelli, Antonio Pollajuoli, and Andrea Mantegna, to whom he communicated the process.

Examples of these sulphur-casts from nielli (or "sulphurs," as they are technically designated) still exist in the museums of the Continent and also in the British Museum. In the British Museum is one of great interest in the history of the art of engraving, it having been taken from a niello in Maso Finneguerra's famous Pax, executed by direction of the Guild of Merchants of Florence for the Baptistery of that city, and now in the Florence Museum. But the Imperial Collection in Paris possesses an impression printed on paper from the silver plate of this very Pax, prior to the insertion of the niello. Now it appears from the great book of the Mercatanti of Florence, cited by Gaye ('Carteggio inedito d'artisti dei secoli 14, 15, 16.' 8vo, Firenze, 1839, i. p. 112), that this Pax was executed in 1450, and hence it has been supposed, from that year being given as the date of the discovery, and from there existing both a sulphur and an impression on paper, that this is the very plate upon which the experiment was first tried. At any rate, it has been regarded as having "established the claim of the Italians to the discovery of taking off impressions on paper from incised metal plates."

Herr J. D. Passavant, however, in a work recently issued ('Le Peintre-Graveur,' Leipzic, 1860), seems once more to have restored the discovery to the Germans. There are, he asserts (p. 192), in the cabinets of Dresden and Munich proofs from nielli executed by German engravers, which leave little reason to doubt that the process of taking impressions on paper from engraved plates was practised in Germany about 1440. But Herr Passavant calls attention to some recently-discovered prints from plates engraved for the purpose of supplying impressions on paper, of an earlier date than the impression from Finneguerra's niello, and others earlier than any known Italian print. The first series consists of a set of seven prints of the 'Passion,' in the possession of M. Renouvier of Montpellier. Only one of them is dated. It represents the 'Flagellation of Our Saviour,' and is inscribed 1446: the execution is rude and archaic; the contours are strongly marked; and the slight indications of shadows are expressed by hatchings, short and irregular in the flesh and the architectural details, but longer in the draperies. A very superior style is exhibited in a print (in the collection of Herr T. O. Weigel of Leipzic) of the 'Immaculate Virgin,' which bears the date 1451. Next in order of antiquity is a series of 27 subjects from the 'Life of Christ,' now in the British Museum, of which 'The Last Supper' is dated 1457. These are the oldest impressions known from engravings properly so called, and (with at least one other dated 1458) they are all earlier than the first Italian prints known, which are those of Baccio Baldini, and are believed to have been executed in 1460.

As regards the first of these prints, there can be no doubt that, if Herr Passavant's description be correct, it is of a much earlier date than the earliest known Italian engraving. Of the second we have some doubt. A fac-simile of it was published in Naumann's 'Archiv.' for 1858, and if that is really a fac-simile it wears a very questionable appearance. The drawing is not only, as Passavant observes, "refined, and founded upon a nice observation of nature," and has "a certain feeling of beauty," but the delicacy and the beauty have a much more modern air than is at all usual in prints of a later date—those of Martin Schöngauer, for instance. We should hardly think it possible Passavant could be deceived as to the genuineness of the print, were he not a German, and likely to look at it therefore with somewhat of national prepossession. On the other hand, the fac-similist may not have copied faithfully, and it is on the side of modern refinement he would be likely to err. As to his third example, we believe (though he does not say so) that he has not seen these prints of the Passion in the British Museum collection. Probably he has obtained his knowledge of them from Waagen, who, in his supplementary volume ('Galleries of Art, &c., in Great Britain,' iv. 49), speaks of them as engravings from metal plates. It is by no means certain, however, that they are printed from metal plates. At the Museum they are placed among the early German wood engravings. They are in fact little more than outlines, and they have been so fully coloured that the ink is for the most part hidden. At the best, from the mode then adopted for printing from wood blocks, it is often very difficult, if not almost impossible, to determine whether a print is a woodcut or a copper-plate engraving; and in this instance it is not only rendered more than usually difficult by their being coloured, but the difficulty is increased by their being printed on vellum, so that no help can be got from examining the back of the print. On the whole then we are disposed to place most reliance on the oldest of these three prints, and if that be authentic it is of course sufficient to sustain the priority of the Germans.

Passavant, indeed, endeavours to show that the Italians acquired the art from the German artists, who are known to have been in the habit of visiting Italy at that time, and an imitation of whose manner of working, he says, is easily traceable in the prints of the early Italian engravers. It hardly seems necessary to resort to such an hypothesis, since the Italians were not only excellent artists, but singularly expert workers in niello; and the engraving of plates for printing would require very little modification of the process to which they were accustomed. In the British Museum however may be seen a couple of prints (of the existence of which Passavant takes no notice), which show that the early Italian engravers were accustomed to look to Germany for the materials of their art. The oldest of these two prints is by the German master of 1466, and is known as 'Our Lady of Einsidlen.' The other is an anonymous Italian print of a 'Youth in Armour,' and is of the latter half of the 15th century. But the remarkable circumstance about them is that both have been executed on the same plate of metal, as Mr. Carpenter (the keeper of the drawings and engravings) discovered when arranging the early Italian and German collections. The earlier engraving of the Master of 1466 had of course been erased to make way for the Italian engraving; but so imperfectly was the erasure made, that portions of the inscription are plainly visible on a careful examination of the surface of the later print. These two engravings, with an admirable selection of rare and choice specimens of the Italian and German engravers of the 15th to the 17th centuries, and also several nielli, and casts and paper impressions from them, are exhibited to the public in the centre of the King's Library. The collection of engravings at the British Museum, we may add, is exceedingly rich in early works, and in the choicest productions of the best engravers; and the collection is admirably arranged: the portion exhibited is but a sample of the treasures stored up in the Print Room.

Our limits will not allow us to dwell on the merits or performances of those early masters, contemporaries of Finneguerra, to whose exertions we are nevertheless much indebted for the rapid approaches of the art towards excellence. Of these, Baldini, Botticelli, and Andrea Mantegna, have already been named among the Italians; while among the Germans, copper-plate engraving was very early and very greatly improved by Martin Schöngauer, Israel Van Mecheln, Leydenwurf, Wolgemuth, &c. The success of the early German engravers is not surprising when we recollect that wood engraving had been first practised in that country forty years earlier, and consequently that they had anticipated the Italians in a knowledge of printing-ink and the press; nay, it is remarkable that the first *book* printed at *Rome* (an edition of Ptolemy's Geography) was also illustrated by the first *plate engravings*, twenty-seven in number, which were maps, and were executed there by two Germans, Sweynheym and Buckink; the latter completing what the former left unfinished at his death. This work is dated 1478, but was commenced in 1472.

One of the first books illustrated with designs on engraved plates was indeed the production of Italian artists; this was the work called 'Il Monte Sancto di Dio,' published at Florence in 1477, and illustrated with engravings by Baccio Baldini, ('Bartsch, Peintre-Gravure, vol. 13, p. 189). An edition of Dante's 'Inferno,' published at Florence in 1481, was also embellished with engravings by Baccio Baldini, after the designs of Botticelli. It is worthy of remark that these plates were not printed on the same paper as the letter-press, but blank spaces were left at the head of each canto, over which the prints were pasted.

Omitting farther notice of those early masters who flourished at the end of the 15th, we shall pass on to the 16th century, at the commencement of which the art was carried to a very high degree of excellence; in Italy by Marc Antonio Raimondi, and simultaneously by Albert Dürer in Germany, and Lucas Van Leyden in Holland: a constellation of talent, the appearance of which marks the most memorable epoch in the history of engraving. The great merit of Marc Antonio lay in the correctness and beauty of his outline: so great is his excellence in this respect, that it is believed that Raphael himself assisted him with his own hand on the copper. The character of his heads is admirably preserved, and the extremities marked with the truest precision; but his lights are not enriched with that variety of fainter tones which indicate local colour, nor do his prints possess the harmony arising from the chiaroscuro or the beauty of reflex light. [Raimondi, Marc Antonio, in Biog. Div.]

Our space will not allow even a list of the engravers and painters who engraved or etched (a mode of engraving hereafter to be described) who flourished in Italy during the two centuries which succeeded the death of Marc Antonio: the principal of these however were Agostino de Musis, Marc de Ravenna, Caraglio, Giulio Bonasoni, and Enea Vico, all pupils of Marc Antonio; Georgio Ghisi of Mantua and his relatives Diana and Adam Ghisi, Cornelius Cort, &c. &c. But although by these and others the executive part of the art was continually though slowly improved, their powers in design or drawing, (in which the chief excellence of the school at all times consisted) declined, at least as fast as they advanced in mechanical skill, until at length in the 18th century the intellectual and mechanical excellences of the art were united in the works of Jacomo Frey; and from that time the credit of engraving in Italy has been well maintained by succeeding artists. The names of the principal painters who have practised engraving in Italy are Agostino Carracci, Stephano della Bella, Spagnoletto, Guercino, Salvator Rosa, Claude Lorraine, Swaneveldt, Canaletti, Piranesi, &c. &c.

In Germany engraving made more rapid strides towards excellence, in the mechanical parts of it; and at the commencement of the 16th century appeared Albert Dürer, a man whose universality of talent extended the boundaries of every department of art, and carried all to a degree of perfection previously unknown in that country. In all that relates to the executive part of the art of engraving the works of Albert Dürer deserve the highest praise. He carried his plates indeed to a much higher degree of finish than his Italian contemporaries, as his print of 'St. Jerome in the Room,' as it is called, the execution of which has scarcely ever been exceeded, will sufficiently attest. To his other honours has been added that of being the inventor of etching by corrosion, an art which has contributed most powerfully to the perfection of engraving. This, however, is at least doubtful, as there are prints in the British Museum (including one referred to by Passavant, which we have ourselves examined) and in other collections, of an earlier date than those of Dürer, which have all the appearance of having been etched. The practice of engraving by erosion with an acid was widely practised centuries earlier, and there can be little doubt that its obvious utility would soon lead the engravers of plates for printing to experiment upon its capabilities. But if not the discoverer Dürer was one of the earliest practitioners of the art; some of the most celebrated etchings from his hand being the prints of 'Christ praying on the Mount,' 1515; the 'Rape of Proserpine,' 1516; and the 'Cannon Landscape,' 1518. All these were evidently performed in the very infancy of the art, before the discovery of stopping out, as it is called, an expression which will be intelligible to the reader on a reference to our account of the process of etching. On examining the etchings of Albert Dürer, we see that they have all been corroded at one biting in; which sufficiently explains their monotonous appearance, and proves that stopping out was not understood, or it would have been had recourse to, as its advantages could not have been overlooked. It is most probable that the defective and monotonous tone occasioned by the want of this knowledge is the reason that so few corroded etchings were executed by Albert Dürer, who must have been otherwise fascinated by the facilities which this mode of engraving offered; as it is, his corroded etchings are much inferior to his other works, both on copper and wood. [DÜRER, ALBERT, in BIOG. DIV.]

The principal German engravers, after Albert Dürer, are his pupil, Henry Aldegraver, together with Bartholomew and Hans Sebald Beham, Albert Altdorfer, James Bink, George Penz, Virgil Solis, &c. But the history of pure German art is very short, for most of these German engravers travelled into Italy for improvement, attracted by the fame of Marc Antonio; several of them are indeed his reputed disciples; and the consequence is, that the two schools may be said to have immediately, in some measure, blended; as under the influence of Italian taste the peculiar characteristics of German art in a great measure disappeared. From the small size of the majority of the works produced by these German engravers, they are generally distinguished as the "little masters," although many large plates were executed by them.

Lucas Jacobs, best known by the name of Lucas Van Leyden, was the father of the Dutch and Flemish schools, and the contemporary and friend of Albert Dürer, whose defects he fully possessed, while he fell short of his excellences. After Lucas Van Leyden the art was maintained in the Low Countries by the Wierinxes, the Sadelers, whose works are multifarious, and embrace every class of subject; the elder and younger Jode; Cornelius, Theodore, and Philip Galle, and Abraham and Cornelius Bloemart. The latter, perhaps less actuated by the commercial spirit in which the art was at this time practised, attempted improvements with success; and by working delicate tints on the lights, which had hitherto been left only as so many white spots, he brought his works to a degree of finish and harmony not previously attained. This artist studied and indeed died at Rome, whither also Goltzius travelled for improvement, who imparted a boldness to engraving which forms a striking contrast to the neat stiff manner of his predecessors. Goltzius was a man of great abilities, and drew the human figure admirably; but in endeavouring to avoid the dry Gothic taste of his countrymen, he went into the opposite extreme. The same observations will apply to the works of Spranghor; and these faults were exaggerated and carried to the extreme of bombast by the disciple of Goltzius, Müller; but the freedom with which he handled the graver is truly surprising. To these succeeded Lucas Killian, Matham, and Saenredam; and at the commencement of the 17th century the two Bolswerts, who had formed their style on that of Goltzius, improved themselves under the instructions of Rubens.

Etching, at this period, was practised by many of the painters in the Low Countries with great success; and we need scarcely say, that it is principally to this process that we are indebted for those treasures of art, the engraved works of Rembrandt: not that in his finished works he confined himself to etching; he also called in the assistance of the graver and the dry point. His etchings being very numerous, are of unequal merit; and many, the subjects of which are of a sacred or dignified nature, are debased by the vulgarity of the characters introduced: but notwithstanding these and other defects, his best works are greatly and deservedly prized, for they are inimitably fine, and possess the excellences of the best paintings, even by his own hand, in a degree not equalled by the works of any other engraver. To mention the artists of this school from whose hands we have etchings would be to name nearly all the most eminent painters belonging to it. Berghem, Cuyp, Karl du Jardin, Paul Potter, Ruysdael, Ostade, Waterloo, Adrian van de Veldt, with many others, have all enriched the portfolio of the collector with works of great taste and skill. Among the more professedly engravers not already noticed we must mention Count Goudt as possessing extraordinary skill, although he cultivated the art less as a profession than for pleasure. The family of the Visschers produced many and excellent works, from the pictures of various masters; and Cornelius Visscher stands particularly distinguished for the accuracy of his drawing and the fidelity with which he has rendered the character of the pictures after which he engraved.

In France engraving has been practised with pre-eminent success in the departments of history and portraiture. The celebrity of the school dates from the time of Louis XIV.; for although several engravers had appeared before that time, it was only under the fostering influence of that monarch, assisted by the fine taste of Colbert, his minister, that a school arose surpassing in excellence any which had preceded it. The family of the Audrans produced six eminent engravers, but of these the most distinguished was Gerard Audran. He was an admirable draftsman himself; but the great excellence of his works in other respects was enhanced by the absence of all *manner*, except such as belonged to the painter after whom he engraved. He was the first engraver who successfully united, to any extent, the use of the graver and the etching point, and by thus availing himself of the facilities arising from the use of the aquafortis, produced numerous works of great excellence and some of prodigious size, among which we may mention the battles of Alexander, after Le Brun, each subject of the series being engraved on three or four large plates. The Abbé Fontenac remarks of him that "far from conceiving that a servile arrangement of strokes, and the too frequently cold and affected clearness of the graver were the great essentials of historical engraving, he gave worth to his works by a bold mixture of free hatchings and dots, placed together apparently without order, but with an inimitable degree of taste, and has left to posterity most admirable examples of the style in which grand compositions ought to be treated."

Gerard Edelinck, although born at Antwerp, may be fairly considered of the French school, and was an engraver of the highest order. In portrait Nanteuil is no less celebrated than his contemporaries: the beauty and clearness of his style has perhaps never been exceeded. The Drevets (Peter Drevet in particular) are scarcely less distinguished; nor must we omit the name of John Louis Roullet, whose engraving of the 'Dead Christ with the fainting Virgin,' after Annibale Carracci, is one of the finest specimens which the art has produced. In addition we can only notice the names of Le Clerc, Simoneau, Chereau, Cochin, Dupuis, Beauvais, Baléchou, Le Bas, John George Wille, &c. &c. The modern and existing French school has produced very able engravers, whose chief defect is, that deviating from the course pursued by Gerard Audran and all the first artists, they allow that which is merely mechanical to predominate in their works; and aiming at great dexterity in the use of the *graver* as the chief objects, they make an ostentatious display of lines, the uniformity and regularity of which often imparts, even to the flesh, the appearance of net-work, when viewed closely.

The English school of engraving dates only from about the middle of the 17th century, but for another century the engravers who practised here were chiefly foreigners. The founder of the British school was William Faithorne the elder, one of the best portrait engravers of his age; he had able contemporaries and successors, but engraving was an exotic in England till the reign of George III., when with a school of painting arose an assemblage of engravers in all the departments of the art who may safely challenge comparison with those of any time or nation.

One of the earliest of these was Hogarth, an artist of most original genius, whose engravings were all from his own designs, in a walk of art entirely new. Landscapes had hitherto never been engraved in a satisfactory manner, the older engravers adhering to the use of the graver *only*, which was inadequate to express with sufficient freedom the playful luxuriance of foliage, the ruggedness of rocks, or the dash of foaming waters. These objects were first accomplished by Francis Vivares, who was a most accomplished etcher, and may be regarded as the father of English landscape engravers, who have unquestionably surpassed all their predecessors in this department of art. Woollett followed in the same tract, carrying his landscapes very forward with the etching point, and finishing them only with the graver. His best works are almost unrivalled; nor was he inferior in history, as his print of the death of General Wolfe, after West, sufficiently attests.

These two artists carried landscape engraving at once to perfection. Browne may be mentioned as a worthy follower; he produced many excellent plates after the old masters, and sometimes worked in conjunction with Woollett. In history and portrait Sir Robert Strange ably vindicated the honour of the art in this countrry: his engraving of flesh has perhaps scarcely been equalled, certainly never excelled by any master: his works are however often much deteriorated by his defective drawing. Mezzotinto engraving, although not strictly born among us, has been in no other country practised with a degree of success at all approaching that attained by M'Ardell, Earlom, Smith, Valentine, Green, and others. Bartolozzi, Ryland, Sharpe, Paul Sandby, Middiman, Milton, Fitler, are among the most eminent of deceased engravers; and Mr. Wilson Lowry is entitled to most honourable mention as a great benefactor to the art, by the invention of the ruling-machine, an instrument of great value for many purposes, and the operation of which is perfect. At present, every department of engraving is filled with artists of great abilities, any of whom it would be invidious to name to the exclusion of others: it is enough to say that their talents and their numbers have given the art a commercial importance in this country to which it never attained in any other.

A modern engraving is usually the result of two processes, namely, of direct incision with the graver, or the dry point, and of etching by corrosion. Line engraving is the highest branch of the art, and that which calls into exercise the full energies of the engraver. In it must be exhibited ample knowledge of the resources of the art, and a skilful handling of the burin. To produce really fine works, the engraver must be himself not merely a clever mechanicien, but an artist, possess the eye and mind of a painter as well as a thorough mastery of his tools. If he have the one as well as the other, he will know how to vary his lines almost indefinitely according to the character of his subject, and the nature of the objects he has to imitate.

The principal instrument of the engraver is the *graver* or *burin*, which differs in size and shape according to the character of the line which it is intended to produce; but the ordinary graver is of the form of a quandrangular prism, both square and lozenge-shaped, and fitted into a short handle, the whole being about five inches and a half long. The square graver is used in cutting broad lines, and the lozenge-shaped for more delicate ones. In making the incision, it is pushed forward in the direction of the line required, being held by the handle at an angle very slightly inclined to the plane of the copper. It is requisite that the graver be well tempered, and great address is necessary in whetting it for use. The angle at the meeting of the two lower sides of the graver forms what is called its belly, and the breadth of the end is called its face. The two sides which form the belly are to be laid flat upon the oil-stone, and rubbed firmly until the belly slightly rises, so that if it were laid flat upon the copper the light could be seen underneath the point; otherwise it would be impossible to use it with freedom, as it would dig unequally deep into the copper. The face is next to be whetted, which is done merely by laying the face of the graver flat upon the stone, with the belly upward, and rubbing it steadily upon a moderate slope until it acquires a very sharp point, taking care that the stone be properly supplied with oil all the while. The gravers sold in the shops are commonly too hard for use, which is known by the frequent breaking of their points: when this is the case they should be tempered by holding them on a red-hot poker, at a distance of half an inch from the point, until they acquire a faint straw colour; they should then be put into oil to cool; or they may be tempered in a candle and cooled in the tallow. But it is best not to be hasty in tempering; for if the graver is only a little too hard, whetting alone will frequently bring it into good condition. An instrument called a *scraper* is required to scrape off the barb or burr which is formed by the action of the graver and dry point. The *burnisher* is used to polish the plate and to erase any scratches which it may accidentally receive, and also to make lighter any part of the work which may have been made too dark. Much of the tone, air, and beauty of finish in a line engraving is due to the dextrous use of the burnisher. An *oil-stone* is requisite for sharpening the instruments upon. *Etching-points* or *needles* are nearly similar in appearance to sewing-needles, but fixed into handles four or five inches long; some are made of an oval form, to produce broader lines with: their use will be explained when we are describing the process of etching. *Dry point* is, in fact, nothing more than the common etching-needle brought to a very fine point. It is used to cut or scratch the more delicate lines with, such as skies, &c. &c. It does not, like the graver, cut the copper clean out, but throws it up on each side of the line produced by its progress through the metal: this is called the burr, which is removed by a scraper. This burr was left on by Rembrandt, until it wore away in the progress of printing, which it soon does; but by his management it added greatly to the effect of the etching, and impressions from his works with the burr on are much valued. A *cushion* is a bag of leather filled with sand; its use is to support the plate so that it may be freely turned in any required direction; but it is not now much used by artists, being chiefly confined to engravers of writing. A *rubber* is a roll of cloth tied up tight, one end being kept in olive oil. It is useful to polish off more completely the burr and also to show the appearance of the work as it proceeds.

Etching is one of the most important processes in modern engraving, almost all plates of every size and description being now commenced by this process, and indeed brought by it to a very considerable effect, and afterwards carried on to the necessary degree of finish and strength with the graver and dry point. Etching is the superaddition of the chemical process of corrosion to drawing, when performed on a plate of copper over which a substance called *etching-ground* is laid, and through which the design is traced with an etching-needle, so as to expose the surface of the copper wherever it has passed. This etching-ground is a substance composed of wax, asphaltum, gum mastic, resin, &c., incorporated by melting over a fire, and capable of resisting the action of aquafortis. The *laying of the ground*, as it is called, is thus effected:—The plate must be heated over a charcoal fire, so that it may not be smoked. For this purpose a hand-vice is fixed to the most convenient part of the plate, by which it may be held in the hand. A piece of the etching-ground, rolled into the form of a ball, and tied up in a little silk bag, is then rubbed over the surface of the plate, the heat of which causes the ground to melt and come through the silk on to the copper. In order to effect a more equal distribution of the wax, a small dabber made of cotton wool, tied up in a piece of taffety, is quickly dabbed all over the face of the plate while yet warm, so as to leave the wax or etching-ground of uniform thickness; the ground is then rendered black, by being held over the smoke of a wax candle, or, if necessary, two or three wax candles tied together, care being taken to move the plate about, so that it be equally smoked all over; and this operation of smoking must be commenced before the plate has had time to cool. The whole operation of laying the ground requires address and dexterity. When cold, the plate is now ready to receive the design. To transfer the design to the copper, an outline is made with a black-lead pencil on a piece of thinnish and even paper, and laid with the face downwards on the etching-ground; the whole is then passed through a rolling-press, the effect of which is to transfer an impression of the outline on to the smoked ground. After this the design is completed with the etching needles, which remove the ground from the copper wherever they pass, and expose it to the action of the acid during the process of biting in, which is thus performed:—A substance called *banking wax*, which when cold is quite hard, but which on immersion in warm water becomes soft, and may be moulded into any form, is first rendered soft by being so immersed in warm water, and then banked up all round the margin of the plate, so as to form a trough capable of preventing the escape of the acid, a gutter only being formed at one corner for the purpose of pouring it off when requisite. This being done, the nitric acid, reduced with water to the proper strength, is poured on, and its action on the copper becomes visible by the rising of innumerable bubbles. The nitric acid must be allowed to continue on the plate until the fainter parts are supposed to be corroded sufficiently deep; after which it is to be poured off, the plate washed with water, and left to dry. The parts which are bitten-in enough, are now to be covered with what is called *stopping-ground*, which is a mixture of lamp-black and Venice turpentine; this is applied with a camel-hair pencil, and allowed to dry. After this the acid is again poured on, and this process of *stopping-out* and *biting-in* is repeated until even the darkest parts are sufficiently corroded. After this the plate is again warmed, when the border of wax may be readily taken off. It is then made warm enough to melt the ground, which is removed by being wiped with a rag and a few drops of olive oil. The work is now complete, unless it is intended to finish it still further with the graver. We might offer rules for the strength of the acid, and state the length of time it ought to remain on the plate, but we are convinced of the inefficacy of such instructions. Nothing but experience, joined to some chemical knowledge of the effect of the acid, will avail the artist on this point, which requires the greatest nicety and attention.

Etching on soft ground is a mode of etching formerly much in use, by which imitations of drawings in chalk and pencil were produced. It is now, to a great extent superseded by lithography, which is more successful in attaining the same objects. Soft ground etching is quite a distinct process from

Engraving in stipple, as practised by Bartolozzi, Ryland, and others, in imitation of chalk drawings of the human figure. Stipple is performed with the graver, which is so managed as to produce the tints by small dots, rather than by lines, as in the ordinary method. It is very soft in its effect, but on the whole much inferior to the more legitimate mode of engraving.

Engraving on steel and *etching on steel* are performed in the same manner as on copper; steel having of late years been often substituted (for book-plates almost invariably) on account of its yielding a greater number of perfect impressions, owing to its superior hardness. The engraving is made on a plate of soft steel, which is subsequently hardened.

Aquatinta Engraving, and *Engraving in Mezzotinto*, are described under their respective titles. [AQUATINTA; MEZZOTINTO.]

Engraving on Stone, or more properly Drawing on Stone, is described, with the cognate process of *Engraving on Zinc*, under LITHOGRAPHY.

Etching on glass is performed by laying on the glass a ground of bees' wax, and drawing the design thereon with the needle, as in etching upon copper. Sulphuric acid is then poured on, and fluor spar, or fluoric acid, sprinkled on it. After four or five hours it is taken off, and the work cleaned with oil of turpentine.

Gem Engraving. [CAMEO; INTAGLIO.]

Medal Engraving. [COIN; MEDAL; DIE-SINKING.]

Machine Engraving. All the kinds of engraving hitherto noticed have been manual operations; the hand of the artist has guided his tools, and the result has depended on the manipulative dexterity no less than on the artistic taste of the engraver. Within the last few years, however, several methods have been introduced of engraving by the assistance of machinery, thus superseding the manual operations of the engraver. The earliest and simplest machine for engraving, the Ruling-Machine, of Mr. Lowry, has already been mentioned. Its object, however, was to assist, not to supersede, the engraver's handiwork; its application being confined to skies, plain back-grounds, and other portions where, if executed by the engraver, the operation was purely mechanical. The saving of labour effected by the ruling-machine is very great, and it has consequently come into very general use. But what is known as *Machine Engraving* is executed wholly by machinery. The machine, however, wonderful as are its operations, is not capable of artistic work. It can execute designs for a great many business purposes, but its chief application hitherto has been to the engraving of bank-notes. [BANK-NOTE MANUFACTURE.] Several machines have been invented for this purpose, but it would be of little use to describe their complex mechanism, if even it were open to description; but it is, in fact, as much as possible kept secret. The principle of all these engraving machines is that of the pantograph [PANTOGRAPH], but the application is complicated by being united with that of the Rose or Guilloche Machine, a familiar employment of which is seen in the beautifully carved ("engine-turned") lines engraved on watch-cases. Messrs. Perkins and Heath were, we believe, the first to introduce this machine practically, and many of their bank-notes and cheques were admirable specimens of workmanship.

The latest and most perfect machine for engraving is that of Mr. F. G. Wagner, of Berlin, which he calls the "Universal Rose-Engine or Guilloche Machine." This machine has besides the Guilloche apparatus, a centric apparatus connected with two excentric, an oval, an angle, and two radiating apparatuses; an apparatus connecting the guilloche and centric apparatus, an apparatus to produce spiral-wave lines in every different shape, and a volute-line apparatus; and these all admit of being used separately, or in combination, in so many ways, and their separate or combined employment can be so variously modified by the distinct motions of the carriages, &c., that a practically unlimited number of patterns can be produced, comprising an endless variety of curved, waving, and spiral lines, drawn with mathematical precision. "The machine," observes Mr. Henry Bradbury, (who has the exclusive possession of it in England,) "is set in motion by means of levers, tooth-wheels, and handles, by which the motive power has no influence whatever upon the correctness and delicacy of the patterns,—properties infallibly guaranteed by the arrangement of the machine. Owing to this simple manipulation, the entire attention may be concentrated upon the composition of patterns, offering a boundless field to the inventive spirit. In spite of the many apparatuses and actions which combine to constitute the Guilloche machine, the management of it is very simple. All the portions remain in constant connection with one another, and may, by means of arrangements of a very simple character, be immediately set in motion, or stopped, as circumstances may require." The machine itself is a singularly elegant piece of mechanism, and unlike the earlier engraving machines, it occupies a comparatively small space.

Medallic Engraving.—In 1830, M. Achille Collas invented a machine for engraving representations of medals, coins, and other objects in relief, which representations should afford to the eye a similar appearance of relief to the medal itself. Shortly afterwards, Mr. Sexton, in America, and Mr. Bate, in London, invented machines which effected a similar object, and, as was said, without a certain "distortion" inevitable in the old machine. A warm discussion was for some time carried on between the advocates of the French and English machines, and their respective merits even engaged the attention of a committee of the House of Commons.

The principle of all these machines is the same. The process of copying medals by them may be familiarly illustrated by a reference to that of the *Silhouette* or profile machine: that is, a pointer at one end of a lever traces over the object to be copied, and a pointer at the other end executes the copy itself. We may suppose a medal to be laid down flat, and that placed near it is the copper-plate on which the engraving is to be made. A peculiar bent lever touches them both, having a tracer-point at one end and an etching-point at the other; the tracer-point comes down vertically on the medal, whereas the etching-point comes nearly horizontally into contact with the etching-ground of the copper-plate. When the tracer-point passes over a flat or level part of the medal, the etching-point marks or engraves a horizontal line on the etching-ground; but when the tracer rises over any of the relief parts of the medal, the etching-point makes a curved line, more or less convex in proportion to the boldness of relief. By passing the tracer-point over every part of the surface of the medal, in parallel lines, the etching-point is made to mark an equal number of lines on the etching-ground of the copper-plate; but these latter lines, instead of being straight and parallel, have varying degrees of curvature. In passing over a sloping part of the device on the medal, the lines in the engraving become either more closely placed or more widely separated than in the former case, according to the direction taken by the sloped surface; they thus give the light-and-shade appearance of a surface in relief. In the original machines, M. Collas carried the tracing-point over the medal vertically, Mr. Bate at an angle of 45°, by which much greater accuracy was ensured. Both these gentlemen subsequently made several improvements in their machines; and other machines, differing in the details, have been invented. The latest, the most elegant as a piece of mechanism, and the most compact, is that of Mr. Wagner, the inventor of the Guilloche engraving machine, noticed above. Among its advantages are, the facilities with which by means of it "copies of relief, in the same proportions as the model, in augmented or diminished proportions, reversed or otherwise, of more or less plastic expression than the model, and of a different point of view, can be produced."

Electro-Magnetic Engraving.—Among the multiplicity of projects which have been put forth for the employment of electro-magnetism, have been several for producing engravings. The earliest machine of this kind that we know of was one by Mr. Hansen, a German, in 1854; one of the latest, that of an American, Mr. Brooman, in 1858. In these machines, as in the engraving and medal machines above described, the incision in the copper-plate is made by a graver working at one end of a bent lever, or series of levers, corresponding in its motion with a tracing-point at the other end, which is carried over the design to be copied. But in these machines the action of the graver is produced by the alternate making and breaking of contact, as is described under ELECTRO-MOTIVE MACHINES. In Mr. Hansen's process, the design is drawn on a metal plate, with a resined ink or other non-conducting substance. In Mr. Brooman's, the pattern-plate is coated with varnish or other non-conducting material, and the design is drawn on it down to the metal. The tracing-point is made to travel successively over every part of the pattern-plate, and whenever it comes in contact with a conducting surface the graver will be pressed down upon the plate to be engraved, and the engraving process will go on till the tracing-point meets with the non-conducting surface, when the circuit will be broken and the graver lifted off the plate. This is continued till the whole of the design is passed over, when a fac-simile of it will have been engraved. We are not aware that any of these electromagnetic machines have been brought into practical operation: the idea is ingenious, but its successful application is very doubtful.

Photographic Engraving. How to employ the Sun as an engraver, is a problem which has engaged the attention of many photographers and men of science in America as well as in Europe. The more successful of their processes will be noticed under PHOTOGRAPHIC ENGRAVING.

Reproduction of Plates.—One of the earliest plans for reproducing engraved plates was that of Messrs. Perkins & Heath. A cylinder of soft steel was passed over an engraved steel-plate, which had been properly hardened, until it received the impression in relief. The cylinder was then hardened, and being rolled upon a *soft* steel plate, transferred to that a fac-simile of the original engraving capable when hardened of yielding impressions as sharp as the original plate. Of course, the cylinder being very hard, several plates could be thus taken from it. The process has been largely employed for commercial purposes, but not as far as we know for artistic work. For both purposes, but especially for the latter a process equally efficacious and less likely to injure the original plate, was discovered in the Electrotype, by which any number of repetitions of a copper or even steel plate, of whatever size or delicacy of execution, may be produced with absolute safety and at comparatively small cost. The process is described under ELECTRO-METALLURGY. It has been extensively employed in the manufacture of bank-notes.

The singularly ingenious *Electro-Block* process of Mr. Collins, by which engraved fac-similes of engravings or designs, of either the same, a larger, or a smaller size, or of altered form, can be produced without the aid of a draughtsman or engraver, is noticed under EARTHENWARE. It is chiefly applied at present to the reproduction of blocks for surface-printing, but it is also applicable to the reproduction of incised plates.

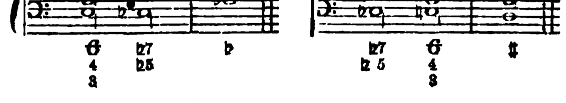
One of the most recent applications of science to the art of engraving, consists in coating the engraved plate with a thin film of some other metal by means of the galvanic battery. Attention was first called to this invention by M. Joubert who in 1858 took out a patent for covering copper plates with an extremely thin coating of iron, a process which he designated *acieraging.* Plates so coated will yield, he found, from 5000 to 9000 impressions; and whenever it may appear desirable, the printing can be stopped and a new coating be applied. Mr. Henry Bradbury shortly afterwards published in the 'Journal of the Society of Arts' (vol. vii. p. 172, &c.), a method he had employed with success, for coating engraved plates with a deposit of zinc, by means of chloride and cyanide of zinc, and a Smee's battery. A plate so coated he found will yield from 1500 to 2000 impressions; and when it shows signs of wearing, the coating can be removed and renewed at pleasure, with great facility and without injury to the plate. He has since employed nickel, which yields 5000 impressions, in the place of zinc, with equal facility, and with little additional cost.

ENGRAVINGS. [COPYRIGHT.]

ENGROSSING; copying in a large hand; the writing a deed in fair, legible characters; from the French *grossir*, to make bigger. Among lawyers it more particularly means the copying of any writing fair upon parchment or stamped paper.

Engrossing also means the purchasing of large quantities of any commodity, in order to sell it again at a high price. It was formerly a very serious offence, but the statutes making Forestalling, Regrating, and Ingrossing criminal, after being long in desuetude, have been entirely repealed. (Blackst. 'Com.' Mr. Kerr's ed., vol. iv.)

ENHARMONIC, the third in order of the three genera of ancient music. The enharmonic genus of the Greeks was distinguishe[illegible]y quarter tones, while the modern scale admits these small intervals theoretically only, not practically, except by a fiction. Thus C sharp and D flat are with the moderns practically the same note, at least on keyed instruments, though, strictly, the former is $\frac{15}{16}$ of the whole string sounding C, the latter $\frac{9}{10}$. The passage from one to the other of these intervals is called an *enharmonic change,* and a change of key so effected is designated by the term *enharmonic modulation.* Examples:—



ENIGMA. [ÆNIGMA.]

ENLISTMENT, a voluntary engagement to serve as a private soldier for a certain number of years, on receipt of a stipulated sum of money. Enlistment differs from enrolment, inasmuch as it is a voluntary act, whereas the latter is, under some circumstances, rendered compulsory: as in the case of men who are selected by ballot for the militia in this country, or who have served in her Majesty's forces, and are enrolled in the Reserve Force under the 22 & 23 Vict. c. 42, or who are raised by conscription for military service generally on the continent.

The practice of impressing men to serve as soldiers, on sudden emergencies, was formerly very common in England; and it is well known that young men were entrapped and secretly conveyed away to recruit the armies employed in the east. The discovery of this illegal and disgraceful method of obtaining soldiers was speedily followed by its abolition; and now, the Indian army, like her Majesty's other forces, is recruited by voluntary engagement.

The number of young men who are induced to enlist by the ambition of entering upon a course of life which appears to hold out a prospect of distinguishing themselves by gallant achievements in the field is, however, too small for the wants of the military service; and the allurement of a bounty must necessarily be presented in order that the ranks of the army may be filled. But the profession of a soldier can never possess such advantages as might induce an industrious man who can obtain a subsistence in another way to embrace it; and it is to be regretted that too frequently those who enter the service are thoughtless youths or men of indolent habits or desperate fortunes. Some attention, however, to the character of a person offering himself for enlistment is necessary if it be desired to render the service honourable: for it is found that idle and dissipated men are with difficulty brought to submit to the necessary restraints of discipline; their frequent desertions entail heavy losses on the government, and they often corrupt those who are compelled to associate with them. When circumstances render it necessary to enlist such men, it is obvious that they ought to be distributed in small numbers among different regiments, and quartered in places remote from those from which they were taken.

By the Mutiny Act it is declared that every person who has received enlisting-money, knowing it to be such, from any military man employed in the recruiting service is to be deemed to be enlisted as a soldier; but within forty-eight hours, and not sooner than twenty-four hours afterwards (any intervening Sunday, Christmas-day, or Good Friday not included), notice is to be given to the recruit, or left at his place of abode, of his having so enlisted; and again, ninety-six hours (any intervening Sunday, Christmas-day, or Good Friday not included), but not sooner than twenty-four hours, from the time of receiving the money, the recruit, attended by any person employed as aforesaid, is to appear before a magistrate (not being a military man), when, if he declare that he has voluntarily enlisted, the magistrate is to question him concerning his name, age, and condition, and physical capacity to serve, and particularly to inquire of him whether he is then serving, or whether he have ever served, in the army or navy. The magistrate is then to read to the recruit the articles of war relating to mutiny and desertion, and administer to him an oath of allegiance, of which a form is given in a schedule to the Act; if the recruit refuse to take the oath, he may be imprisoned till he do so.

But as the young and simple have been sometimes inveigled by illusory promises, or persuaded, while deprived of judgment by intoxication, to enlist, if a recruit, on reflection, wish to withdraw from the engagement into which he may have been surprised, it is provided by the Mutiny Act that when taken before the magistrate as above he shall be at liberty to declare his dissent from such enlistment; and on making this declaration and returning the enlisting-money, with 20s. as smart-money, and all pay received by him as a recruit, he shall be forthwith discharged. But if he omit within twenty-four hours after declaring his dissent to pay such money, he is to be considered as enlisted, as if he had given his assent before the magistrate.

If a recruit, after receiving the enlistment-money, and, after notice of having enlisted has been left at his place of abode, shall abscond, he may be apprehended and punished as a deserter, or for being absent without leave; and if it be discovered that he is unfit for active service, in consequence of any infirmity which he had not declared before the magistrate, he may be transferred to any garrison, or veteran or invalid battalion, though he may have enlisted for some particular regiment. If it be proved that the recruit concealed the fact of his being a discharged soldier, or any infirmity which incapacitates him for the service, or made any false representation, he may be sentenced to suffer punishment as a rogue and vagabond; and if in consequence of false representations he shall have obtained enlisting money, or bounty, he may be prosecuted for obtaining money under false pretences, or in Scotland for falsehood, fraud, and wilful imposition; and if, at the time of enlisting, he falsely denied being in the militia, if a volunteer, he may be committed to the House of Correction for any time not exceeding fourteen days, and if a substitute or balloted man, for any period not exceeding six months; and, from the day in which his engagement to serve in the militia ends, he is to be deemed a soldier in the regular forces.

An apprentice who shall enlist, denying himself to be such, is deemed guilty of obtaining money under false pretences; and, after the expiration of his apprenticeship, he is liable to serve in her Majesty's forces; but a master is not entitled to claim an apprentice who may have enlisted unless the claim be made within one month after the apprentice shall have left his service, and unless the apprentice shall have been bound in England (when not above fourteen years of age) for seven years, or in Ireland and the British Isles (when not above sixteen) for five years, or in Scotland by regular contract or indenture for four years.

In the Mutiny Act it is also enacted that no man enlisted as a soldier is liable to be arrested on account of any process for leaving any relation or child chargeable to a parish, or on account of any engagement to work for an employer (except that of an apprenticeship), or on account of any debt under 30*l*. It is enacted that all negroes or persons of colour, although not born within the possessions of the crown, who shall voluntarily enlist, and all negroes purchased for the crown previous to the abolition of slavery, and all negroes seized and condemned as prize under the slave trade Acts and appointed to serve in the army, shall while serving be deemed to be soldiers legally enlisted, and be entitled to all the privileges of natural born subjects. Every military officer acting contrary to the provisions of the Mutiny Act, in what regards enlisting recruits, is liable to be cashiered.

During the reign of Queen Anne it was the custom to enlist recruits for three years; but this period seems too short, considering the time unavoidably spent in training the men, to afford the government an advantage adequate to the expense of maintaining them; and the practice which afterwards obtained of enlisting for an unlimited period was deemed by parliament to be impolitic. It was therefore enacted by the 10 & 11 Vict. c. 37, that no person should be enlisted for the British army or the Indian army to serve in the infantry for a longer period than ten years; or in the cavalry, artillery, or ordnance corps, for more than twelve years; reckoning from the day of attestation, or on which the recruit shall attain the age of eighteen, whichever is latest, subject however to any order in council shortening such period by virtue of a temporary Act subsequently passed.

The advantages of a limited period of service are, that a greater number of recruits are obtained under that condition, probably because men are more willing to engage themselves for a certain number of years than for life; and that, during the period, opportunities are afforded of discovering the character of a man. Should this be such as to render it not advisable to retain him, he may be discharged at the end of his time of service; while an additional bounty, strengthened by the unwillingness of most men to leave the comrades with whom they have been long accustomed to associate, will probably induce a good soldier to re-enlist should the continuance of his services be desired.

By the 5 & 6 Will. IV. c. 24, and the 16 & 17 Vict. c. 69, together with certain orders in council approving and confirming the recommendations of the Board of Admiralty, a man may enter himself on the books of the Royal Navy for a period of five years, or with increased pay and other advantages for continuous and general service during ten years, after which he is entitled to his discharge, and to be sent home if abroad, unless the commanding officer should consider his discharge detrimental to the service. Such officer is in that case empowered to detain the man six months longer, or until the emergency shall cease, and the man so detained is entitled to twopence a day in addition to the pay of his rating. The crown is empowered to require by proclamation any one in the navy to continue to serve for any time not exceeding five years after the expiration of his period of service; but the man so detained is entitled to any bounty offered by the proclamation.

The period of enlistment in the Marines is determined by the 10 & 11 Vict. c. 63 to be twelve years, subject to any reduction of that period to be made by order of the Board of Admiralty, in pursuance of the 20 Vict. c. 1. The Board of Admiralty are also empowered by the 16 & 17 Vict. c. 73 to raise a body not exceeding 10,000 men to be called the "Naval Coast Volunteers," to be enlisted for five years, to be out for training either on shore or shipboard twenty-eight days in each year, and to be liable in case of imminent national danger to be called into active service by royal proclamation; and by the 22 & 23 Vict. c. 40, to raise a reserve force of 30,000 men, to be called the Royal Naval Volunteers, subject to similar conditions and liable to similar services. The coast-guard as previously constituted, and capable of being increased to 10,000 men, has also been placed under the control of the Admiralty, and made subject to similar discipline to that which prevails on board the Royal Navy.

By the 59 Geo. III. c. 69 it is made a misdemeanor, and punishable accordingly, for any British subject to enlist, or consent to be enlisted, to serve in any foreign army or navy.

ENOCH, the Book of, is one of the Hebrew Scriptures which, with several others, were designated Apocryphal. [APOCRYPHA.] During the apostolic age the book of Enoch was commonly read by Jews and Christians. St. Jude, in his catholic epistle, cites it as the work of a divine prophet ("Enoch the seventh from Adam prophesied, saying," &c., v. 14, 15), so Tertullian ('De Idolatria') refers it to the inspiration of the Holy Spirit: however, in another treatise ('De Cultu Fœminarum') he states that by some it was not received. Irenæus, Jerome, and other fathers, respectfully notice it, though not as canonical; and Origen ('contra Celsum,' lib. v.) observes that, in his time, it was not of great authority in the churches. In the Testament of the Twelve Patriarchs, translated by Robert Grosthead, bishop of Lincoln, the sons of Jacob speak often of reading in the book of Enoch. It was extant among Christian writers until the 8th century, when it appears to have been lost. Several fragments, however, remained, which, with a few citations collected from the fathers and succeeding writers, supplied the only data for the critical discussions of learned divines during several centuries. All these relics, amounting to about 20, are inserted in the 'Codex Pseudopigraphus Vet. Test.' of Fabricius, tom. i. p. 160–224.

At the end of the 18th century Bruce brought from Abyssinia three complete and beautiful copies of the book of Enoch, in the Ethiopic language, one of which he presented to the Bibliothèque du Roi at Paris, and another to the Bodleian Library at Oxford. Transcriptions and partial translations into Latin were made by Dr. Woide of Oxford and Dr. Gesenius of Halle; but the Ethiopic MS., which at first excited much curiosity, lay undisturbed during more than a quarter of a century, until the professor of Hebrew at Oxford, Dr. Lawrence, broke in, as he informs us, upon its repose, and published in 1826 an English version of the whole, entitled 'The Book of Enoch the Prophet, supposed for ages to be lost; translated from an Ethiopic MS. by the Rev. Richard Lawrence, LL.D., archbishop of Cashel.' A second and revised edition appeared in 1833. That this book is identical with that which, in the primitive ages of Christianity, was cited by Jude and the fathers, is considered by Dr. Lawrence to be completely evident. His critical prolegomena and notes are incorporated in a more recent translation into German, which is accompanied with a much larger mass of learned researches, forming two thick volumes 8vo. ('Das Buch Henoch, in vollständiger übersetzung mit fortläufenden Commentar, ausführlicher einleitung, und erläuternden excursen, von Andreas Gottlieb Hoffmann, Doct. Philos. Profess. Theol. an der Univers. zu Jena,' 1833.) As the allegorical statements of the book, as far as any meaning is clearly assignable, appear to relate to historical events which extend to the time of Herod the Great, it is supposed by those who reject the supposition of its being the antediluvian production of Enoch himself that it was anonymously written in Hebrew, shortly before the commencement of the Christian era. (Scaliger and Lawrence.) The subject matter consists chiefly of relations of Enoch's prophetical and celestial visions, in the most remarkable of which the angel Uriel (lxx. et seq.) shows to the prophet all the mysterious scenes in heaven, including a survey and explanation of the solar and lunar revolutions according to the ancient astrological theory. A view is also exhibited of the interior of hell. Occasionally religious and moral precepts are enjoined, but all sense of propriety is continually shocked with such preposterous combinations that Scaliger, judging merely from the fragments then possessed, scrupled not to designate the book as a tissue of disgusting lies and nonsense. ('Scaligeriana.') It commences with some historical statements, of which the following, from chap. 7, is a specimen:—"To the sons of men were born elegant and beautiful daughters, and when the angels, the sons of heaven, beheld them, they became enamoured of them, saying to each other, 'Come, let us select wives for ourselves and beget children.'" Accordingly a band of 200 angels having descended on Mount Arnon, and sworn to accomplish this project, "they then took wives, each choosing for himself; with whom they cohabited, teaching them sorcery and incantations; and the women conceiving, brought forth giants, whose stature was each three hundred cubits (450 feet): these, when they had devoured all the produce of man's labour, began to devour men, birds, beasts, and fishes, eating their flesh and drinking their blood." In representing persons and events by animals and inanimate objects of nature, combinations are introduced of such a monstrous nature, that, in comparison, the metamorphoses of the Pagan mythologies appear to be rational. The history of the prophet to whom this book is attributed, or rather whose visions it relates, is briefly recounted as follows, in Genesis v. 18–24:—Jared at the age of 162 begat Enoch, who at the age of 65 begat Methuselah, and afterwards walked with God 300 years, and begat sons and daughters. All the days of Enoch were 365 years; he walked with God, and was not, for God took him. (Compare Ecclesiasticus xliv. 16; Heb. xii. 5.) From the fact of his being the seventh from Adam, from the number of the years of his age being precisely the number of days in the year, and from several other points of curious coincidence, the sceptical Boulanger asserts, in a learned treatise on the subject ('Enoch,' in 'Œuvres Diverses'), that the name is but a variation of the Phrygian Annac, a symbolical personification in Sabism, representing the solar period; and identical with the Oriental Anusch, the Phœnician Anac or Enac, the Etruscan Anus, and the Latin Janus.

ENROLMENT, in law, is the registering, recording, or entering a deed, judgment, recognizance, acknowledgment, &c., in Chancery or in some other court having authority to receive such enrolments. The enrolling does not make a deed a record, though it thereby becomes a deed recorded; for there is a difference between a matter of record and a thing recorded to be kept in memory; a record being the entry of judicial proceedings in a court of record; whereas an enrolment of a deed is the private act of the parties concerned, of which the court takes no judicial notice. Various statutes have directed instruments to be enrolled, the best known of which is the 27th Henry VIII. c. 16, relating to deeds of bargain and sale of freehold lands. The registration of bills of sale [BILL OF SALE] is of the nature of an enrolment, although every registration of a deed is not. Thus deeds relating to property in the counties of York and Middlesex are registered in the registrar-offices there established by statute: they are not enrolled.

ENSIGN, a commissioned officer, the lowest in degree, and immediately subordinate to the lieutenants in a regiment of infantry. One of this rank is appointed to each company, and the junior ensigns are charged with the duty of carrying the colours of the regiment. Ensigns in the regiments of foot guards have also the rank of lieutenants. In the Rifle Brigade, Fusileer regiments, and in the royal corps of Artillery, Engineers, and Marines, in place of an ensign a second lieutenant was formerly attached to each company. The title of second lieutenant is now however abolished, the title of ensign being resumed in the Rifle Brigade and Fusileer regiments; whilst in the Artillery, Engineers, and Marines, all the subalterns are called lieutenants, those that would have been second lieutenants, however, only receive second lieutenant's pay.

Among the Spaniards and Italians, in the 17th century, it appears that no officer existed like the lieutenant of a company, whose rank is between that of a captain and ensign, any such being considered superfluous, and as tending to diminish the importance which was attached to the post of the officer who had the charge of the colours, on the preservation of which in action, the honour of the regiment was made greatly to depend.

When, as formerly, a battle partook far more than at present of the nature of a melée, the loss of a standard, which served as a mark for the soldiers under each leader to keep together in the fight or to rally when dispersed, must have been a serious misfortune, and probably was often attended by the total defeat and destruction of the party; and hence, no doubt, arose the point of honour respecting the colours. A French military author, who served and wrote in the time of Charles IX., intending to express the importance of preserving the colours to the last, observes that, on a defeat taking place, the flag should serve the ensign as a shroud; and instances have occurred of a standard-bearer who, being mortally wounded, tore the flag from its staff and died with it wrapped about his body. Such a circumstance is related of Don Sebastian, king of Portugal, at the battle of Alcazar, and of a young officer named Chatelier at the taking of Taillebourg, during the wars of the Huguenots.

In the old French service, the duty of carrying the oriflamme at the head of the army was confided to a man of rank, and also of approved valour and prudence. The post was held for life.

The price of an ensign's commission in the foot guards is 1200*l.*, and his daily pay is 5*s.* 6*d.*; in the regiments of the line the price is 450*l.*, and the daily pay 5*s.* 3*d.*

ENTABLATURE. [COLUMN; GREEK ARCHITECTURE.]

ENTAIL. [ESTATE.]

ENTERI'TIS, *Inflammation of the Intestines.* The inflammatory affections of the whole alimentary canal constitute an extensive and highly important class of diseases, several of which are properly designated by specific names, since they have a peculiar seat and require a peculiar treatment. Enteritis is one of these. This term is employed to denote an acute inflammation of the external or peritoneal coat of the intestines. When inflammation is seated exclusively or chiefly in the peritoneal coat of the intestines, both the local and the constitutional affection is widely different from that which is produced when inflammation is seated in the mucous coat. It is, therefore, with good reason that these diseases are distinguished by different names.

The distinctive characters of enteritis are pain in the bowels, vomiting, invincible constipation, fever, and sudden and great prostration of strength.

The pain is often exceedingly severe, and is usually especially acute about the navel. The inflammation may be confined to a small portion of the intestines, or its seat may be very extensive. The pain is felt in the part in which the inflammation is seated: hence the pain is occasionally restricted to a particular part of the abdomen; but far more commonly it is spread over a large portion of it, and, as has just been stated, is peculiarly severe about the navel. The pain is constantly present; it is never for a moment entirely absent; but it is occasionally very much aggravated in paroxysms. It is always *greatly* increased by pressure over the seat of the part inflamed. Though severe pain be a very constant attendant on enteritis, yet occasionally cases occur in which the pain is never so great as to occasion much alarm, and these insidious attacks are the most dangerous.

The vomiting, though occasionally absent, is pretty constantly present, and is sometimes frequent and most distressing. In the intervals between the acts of vomiting there is a sense of nausea. It has been thought that when the vomiting is urgent, it is an indication that the inflammation has extended to the stomach; but the inspection of the body after death has fully shown that there may be most distressing vomiting when not the least appearance of disease can be traced in the stomach.

Obstinate constipation is a diagnostic mark of enteritis. It is not, indeed, invariably present; but it is present in so large a proportion of cases, that when absent it must be considered as an exception to the general rule. Its absence should leave no doubt upon the mind of the nature of the attack if the other symptoms are present.

More or less fever is always present. The skin is usually hot and dry, and the heat is often preceded by a sense of chilliness or by a distinct rigor. The tongue is usually white and furred; there is much thirst, and the pulse is quick, small, sharp, and incompressible.

The expression of the countenance is peculiar. The features are sharp and compressed; in severe cases, and in almost all cases in the advanced stage, quite sunk. The expression is anxious and wild, and the first glance conveys to the beholder an irresistible conviction that the individual is labouring under some intense internal disease.

The impression upon the powers of life is so great and rapid that he patient is far more exhausted after a few hours' illness in this disease than after an attack of as many days' duration in most other acute maladies. This rapid and extreme prostration is highly characteristic of enteritis; and if it be combined with any one of the symptoms which have been described, should leave no doubt of the existence, in an intense form, of one of the most dangerous diseases to which the human body is subject.

As the inflammation advances, the pulse becomes more rapid and feeble; the abdomen swollen, tense, and tympanitic; the prostration increases; the skin, instead of being hot, becomes cold and clammy, and the extremities, more especially, are cold.

The inflammation has a peculiar tendency to terminate in gangrene. Before this event happens, it is usually conceived that the inflammatory action extends from the peritoneal to the muscular coat, and that in the most intense cases all the coats of the intestine become involved. The signs that mortification has taken place are, cessation of pain, hiccup, increased frequency and weakness of the pulse, greater collapse of the countenance, and increased prostration. But it is remarkable, that often when the patient dies under the ordinary symptoms of mortification, on the examination of the intestine after death, nothing can be detected but the usual appearances of inflammation; there is no trace of a gangrenous spot; death is produced by the intensity of the inflammation.

The brain usually remains unaffected to the end; the mental faculties are but little impaired; but sometimes, as the disease advances, the mind becomes confused and wandering, and occasionally delirium sets in early,—a certain sign that the disease is of extraordinary intensity.

The exciting causes of the disease are, acrid and indigestible matters taken into the stomach in large quantity; habitual full living on highly seasoned food; the accumulation of hardened fæces; cold drinks, especially when the body had been previously overheated. But perhaps the most common cause of the disease is cold, combined with moisture, applied either directly to the abdomen, or to the body generally, and more especially to the lower extremities. It is also frequently superinduced by strangulated hernia; and on the sudden occurrence of the symptoms of enteritis the abdomen should always be carefully examined, with a view to ascertain whether hernia be present. It may also be caused by an event which cannot be known until after death,—the involution of one fold of the intestine within another (intus-susception or volvulus), so as to occasion a complete obstruction to the passage of the contents of the bowels.

Enteritis can scarcely be confounded with any other disease excepting colic, and the relation between these two affections is so close that severe colic is very apt to lapse into enteritis; and this it is very important that the practitioner should bear in mind. But when colic exists as a distinct disease it is clearly distinguished from enteritis by the absence of fever, and of the prostration so characteristic of enteritis; by the occurrence of the pain more decidedly in paroxysms with intervals of complete ease; by the diminution, not the increase, of the pain on pressure, and by the strikingly different state of the pulse.

Enteritis may attack persons of all ages, from the infant a day old to the man who reaches the extreme term of human life. It may occur at all seasons of the year. Its attack is often sudden, and it sometimes proves fatal with frightful rapidity. It is by no means uncommon for a person apparently in sound health to be destroyed by this disease within twenty-four hours from the commencement of the attack.

Hence the importance of a knowledge of its early symptoms, and the necessity of attacking it with the utmost promptitude and vigour. The ordinary remedies for inflammation must be employed with decision. The character of the pulse, the sunk countenance, the prostration of strength, may appear to contra-indicate blood-letting; but these are false indications, and if regarded, the event will be fatal. After a copious bleeding the pulse often diminishes in frequency and increases in strength; the expression of the countenance improves, and the vital energies recover, as if the system were relieved of an oppressive load. Bleeding must be carried as far as possible, until it appears to have made an impression upon the inflammatory action. It is a very useful practice to bleed from the arm two or three times in succession, after an interval of two or three hours, if the symptoms of inflammation do not abate.

It is without doubt highly desirable to procure evacuations from the bowels; but the disease is to be cured by the removal of the inflammation, not by opening the bowels. Death often takes place though the bowels are opened, and the fatal event is not unfrequently hastened, if not brought about by the acrid nature of the cathartics given to remove the constipation. These acrid cathartics, if they open the bowels, do not necessarily save the patient; and if they do not open the bowels they greatly increase the inflammation. Only the mildest aperients should be employed. This is one of the diseases in which the judicious employment of calomel and opium is attended with the best results.

Colic is often converted into enteritis, or a case of enteritis mistaken for colic is frightfully aggravated, by taking spirituous cathartics, as tincture of rhubarb, for the relief of the pain. In no case whatever should any vinous or spirituous cathartic be taken for pain in the bowels, however slight, without the sanction of a medical man. Persons continually sacrifice their lives by taking brandy, or a large dose of some tincture, for what they call spasm of the stomach or bowels. The so-called spasm oftentimes is inflammation, which the stimulus of the alcohol increases to such a degree that the disease is no longer to be restrained by any remedies that can be employed.

Inflammation of the mucous membranes of the intestines, called *enteria*, or *enteritis erythemoidea* is attended with a different set of symptoms. In this case, the bowels are generally relaxed. There is griping pain which is generally referred to the umbilicus or right iliac porea. There is inclination to sickness, and the bowels are frequently distended with flatus. There is coldness of the surface, with frequent shivering. The tongue is moist, but viscid, clammy, and furred. The abdomen is not tender when pressed, but there is a general sense of uneasiness. The stools are at first feculent and large, but afterwards become scanty, frequent, and watery, containing undigested food, and sometimes blood.

In these cases the mucous membrane is highly congested, and ulceration is constantly present.

The treatment consists of bleeding by leeches, warm fomentations, acting on the bowels by gentle purgatives combined with opiates. Where the pain is violent opium should be given to relieve the pain.

ENTOMO'LOGY, that branch of science which treats upon insects. The term *entomology* literally signifies a discourse upon insects, it being derived from the two Greek words, *éntomon*, an insect, and *logos*, a discourse.

The term entoma was first applied to these animals by Aristotle, and is synonymous with the Latin word insecta (whence is derived the English name *insects*), both having reference to a striking character exhibited in the insect tribe, that of having the body *insected*, or, as it were, cut and divided into numerous segments.

ENTOZOA. [Worms.]

ENTRESOL, a French term used to signify a floor between other floors. The entresol consists of a low apartment or apartments, usually placed above the first floor. The Italian form, mezzanine, is now perhaps more frequently employed than the French one; and the mezzanine is in London often placed above the ground floor. In street architecture it is desirable to form the basement story on a scale of grandeur, and in so doing a greater space than necessary would frequently be given to the first floor, if it were not for the entresol.

There is a good example of an entresol in the Regent Street Quadrant in London, and it has been introduced in many other cases where the lower floor has been intended for shops. The entresol is a frequent feature in the architecture of Paris.

ENTRY (from the French *entrée*, and Latin *intrare*, to enter), in Law, is a taking possession by the legal owner of lands and tenements when another person is wrongfully in possession of them. At the common law this might be effected by force; but as it was the cause of great abuses, forcible entries were made punishable by fine and imprisonment by two statutes of Richard II., which were enlarged by the statute 8 Henry VI. c. 9.

The effect of an entry was formerly to keep alive the assumed right of the person making the entry to the premises he entered on. This was effected by an annual repetition of the entry, which was called *continual claim*. The party availing himself of this summary process entered upon some part of the property claimed, and formally declared that thereby he took possession of the whole; and the entry was repeated in each county in which the lands lay.

The statute 3 & 4 Will. IV. c. 27, in effect abolished this practice by making twenty years' possession a good title to land, and at the same time abolishing the ancient writs of entry, which the *continual claim* above alluded to entitled the party to bring at any time. An entry on lands has accordingly no effect now, unless the tenant in possession admits the right of the person making the entry, the effect of which is that he is at once in possession of the property. When the right is not admitted, the entry has no effect, and the claimant must proceed by ejectment.

Entry, forcible, is an entry made with a strong hand, with unusual weapons, an unusual number of servants, or with menace of life. If effected with violence, and the entry only amounts in law to a trespass, it is not within the meaning of the statutes of Richard II. above referred to. The remedy for parties aggrieved, and the mode of obtaining restitution, is either by an action at law, by indictment, or by justices of the peace upon the view. If made by more than three persons, they may be proceeded against as in case of a riot.

Entry, the writ of, was the ancient method of gaining possession of disputed property by trying the title of the occupant. This writ was directed to the sheriff, requiring him to command the tenant that he render to the demandant the premises in question. The tenant thereupon was either compelled to deliver up the possession of the land, or to show cause why he refused to do so. This might be done by justifying his own title or that of others under whom he claimed. The claims of the respective parties were then tried before a jury, and the possession of the land was awarded to him who produced the clearest evidence of his right.

There were several writs of entry both at the common law and by statute, but they appear to have long fallen into disuse before their final abolition by the stat. 3 & 4 Will. IV. c. 27. The learning respecting them, which is somewhat curious, may be found in Reeve's

'History of the English Law.' (Blackst., 'Comm.,' Mr. Kerr's ed., v. ii., p. 191; v. iii. p. 183.)

ENVELOPE-MAKING. Until the introduction of the great change in the postal arrangements of the United Kingdom about twenty years ago, envelopes for letters were very little used. There was sufficient reason for this, seeing that double postage was charged for any letter consisting of two pieces of paper. The letters themselves were directed and sealed, or wafered, without exterior coverings. When, however, letters were charged only with a postage-rate by weight, the same obstacle did not exist; and it disappeared entirely when the penny rate commenced, whereby a moderately sized letter and its envelope could both be conveyed to any part of the United Kingdom for one penny. In 1839, just before these changes were made, the letters posted in or passing through the whole kingdom were about 76,000,000 annually; since which time they have risen to 523,000,000 in 1858, under the influence of cheapness and efficiency. The manufacture of envelopes has hence become a matter of some importance; for nearly all letters are now enclosed in such covers, except certain official kinds. The number of envelopes actually made is not correctly known; for large numbers are used for purposes which do not bring them within notice of the postal authorities. The French used envelopes before they were much employed in England; and the Americans send over large quantities made of a peculiar kind of drab or buff paper; but the great proportion are of home production, and, in the present day, machine-made. At first, a hand-method was adopted for cutting, folding, and gumming. The sheets of paper were in the first place shaped by sharp cutters, acting against the edges of guide-plates, and penetrating several layers of paper at once. The shaped pieces were then folded, something in the same way as the sheets of paper for bookbinding; an expert worker could fold three thousand in a day, but not so uniformly and symmetrically as they are now folded by machine. The gumming, and the embossing on the loose flap, were subsequent operations. Envelopes are still made in this way; but there are no means of knowing what ratio they bear to those made by machine.

Although the extensive use of envelopes began in 1840, and the ingenuity of inventors was soon afterwards directed to the possibility of producing an envelope-making machine; it was not until 1851 that the public became familiar with the results. Messrs. De la Rue's envelope-machine was one of the most attractive objects at the Great Exhibition in Hyde Park—throwing off its three thousand envelopes per hour, and showing how much may now be effected by the labour of one or two persons. There was another machine exhibited, and many specimens of envelopes unaccompanied by any notice of the mode of manufacture; but the one above adverted to was that to which attention was most deservedly directed.

This highly ingenious machine, the joint invention of Mr. Warren de la Rue and Mr. Edwin Hill, was patented in 1845; and to it were made certain additions which were the subject of another patent in 1849. The paper is not cut to the proper lozenge or diamond shape by the machine itself, but by a cutting apparatus used separately. Nor does the machine feed itself with these blanks; it is fed by an attendant at the rate of about sixty a minute. When the blanks have been cut out, and embossed with any device that may be chosen, each one is placed in turn on a small table or stand. A compound box or plunger descends, presses the paper into a recess, and makes four creases in it, in such way that four flaps stand upright. Four folding levers, which act the part of fingers, then descend one after another, and fold the four flaps of the envelope. After the end flaps have been turned down, however, and before the side flaps are similarly treated, a gumming apparatus moves forward, and applies a little gum to those parts which are to be fastened together. This gumming apparatus is beautifully contrived; an endless band moves through a trough of gum or adhesive composition, takes up a portion and imparts it to a sort of printing-lever, which in its turn transfers the gum to the paper. When this is completed, the gumming apparatus withdraws, and the folding levers press down the remaining flaps of the paper. The automatic action of the machine instantly removes the finished envelope, to make way for another. To prevent the flaps from flying open again while the gum is yet moist, each envelope is transferred to the *bottom* of the heap already made, so as to receive pressure for a short time; two levers acting like fingers, tipped with india-rubber to render them slightly adhesive, draw the envelope sideways, and carry it to a point where an endless band takes it under a roller to receive a slight pressure, and then deposits it at the bottom of a previously made heap of envelopes, lifted up for that purpose. By a little adjustment of the mechanism, the folders can be adapted for envelopes of different sizes. As the feeding of the machine must be as rapid as the cycle of operations, any failure in it would produce mischief; if a blank were not deposited on the proper spot at the proper instant, the gum would wet the small table, and thus spoil the next envelope; and at the same time a disarrangement of the finished heap would take place. The attendant is provided with means for avoiding these two evils, without stopping the machine. One machine can make 30,000 envelopes in a day.

Another envelope-making machine, exhibiting great ingenuity, was patented by M. Rémond, in 1849, and was afterwards purchased by Messrs. Dickinson, to be used in their paper works at King's Langley. This machine is self-feeding. A hollow arm, moving backwards and forwards, is alternately exhausted and filled with air; in its exhausted state, it comes down gently upon a heap of paper blanks, one of which slightly adheres to it by a species of suction; the arm moves on, becomes filled with air, and drops the blank on a moveable table. The blank is then pressed against two pieces of sponge saturated with gum, by which it is gummed just in the right places for fastening. After this, the folding is effected by a combination of plungers and folding-levers. The machine is more automatic than De la Rue's in regard to the feeding, but not so much so in the pressing and final removal of the envelopes.

There are other envelope-making machines which have been patented, but which need not receive any lengthened notice here. Messrs. Pollard and Mumby's machine is intended to effect the feeding, gumming, stamping, folding, and delivering, all by the aid of one person. The blank is fed upon a folding-box, and gummed on the lower flap. At the same time it is embossed or stamped on the opposite or seal flap, and with the maker's name on one of the end flaps. A folding-plunger then descends into the folding-box, driving up the edges of the paper into a vertical position; the plunger then rises; and spring incliners give the necessary inclination to the flaps. The plunger descends again, and presses down the flaps on the gummed surface. The envelope finally falls from the box upon a moveable bottom. Shaw's envelope machine was intended by its inventor as an improvement on Rémond's. It has an adhesive substitute for the pneumatic feeder, which takes the blanks one by one off the heap; this substitute is made of india-rubber treated with turpentine. There are also elastic revolving surfaces acting in conjunction with the plunger; four rollers covered with india-rubber form the sides of the folding-box; and a plunger drives the blank down between the rollers. In Addenbrooke's patented machine, an attendant places the blanks on a feeding-table, adjusts it by guide studs, and works a treadle. A complicated system of rollers, arms, excentrics, springs, levers, flies, screws, fingers, and plungers is set in action; a gum-box, gum-distributor, and gum-pad do one part of the work; after which, the creasing and folding are effected nearly in the same manner as in the machines already described. The envelopes are finally deposited on an endless band, which carries them away to a receptacle. Keith's envelope-machine, like most of the others, requires that the blanks should be fed in by hand; they are creased by the descent of a plunger into a creasing-box; a partial exhaustion of air then holds the paper in the box while the plunger rises. The box then advances to another plunger, for folding and pressing the flaps; this second box has projecting sliding pieces, which first turn down one of the flaps, and then lay the end flaps upon it. There is an air-exhausting apparatus connected with the plungers.

ENVOY, a diplomatic minister or agent, inferior in dignity to an ambassador, but generally invested with equal powers. [AMBASSADOR DIPLOMACY.]

EOS ('Ηώς), in Greek mythology, the Goddess of the Morning; the Aurora of the Romans. The daughter of Hyperion and Theia, and the sister of Helios and Silene, it was her task to precede the chariot of the sun, and announce the coming day. By Tithonus she was the mother of Memnon and Emathion. She urged Zeus to render Tithonus immortal; but having forgotten to ask that he should retain his youth, he at length withered away and she changed him into a cricket. She carried off Cephalus from Mount Hymettus, and became by him the mother of Phaëton, but eventually allowed him to return to his wife Procris. The splendour of Eos, or Aurora, was a frequent theme of the Greek and Roman poets. She was also a favourite with the ancient artists. There are many representations of her both in sculptures and on vases. The carrying off of Cephalus occurs frequently. Sometimes she is represented in a magnificent quadriga, at others guiding the horses of the sun; or again preceding or pursuing Orion.

EPACT, the number of days in the moon's age at the beginning of the year.

EPAULEMENT is the term properly applied to the mass of earth, about 7 feet 6 inches high and 18 or 20 feet thick, which is raised for the purpose of either protecting a body of troops from the enemy's fire, or of forming a wing or shoulder of a battery to prevent the guns from being dismounted by an enfilading fire. It is in fact the term applied to many works of merely passive defence. The term is occasionally, improperly however, used to designate the whole mass of earth or other material which protects the guns in a battery both in front and on either flank; and it can only be distinguished from a parapet by being without a banquette, or step, at the foot of the interior side, on which the men stand to fire over a parapet. That part of the epaulement which is between every two embrasures is called a merlon; and the part under the embrasure is called the genouillère.

EPHEMERIS (ἐφημερὶς, from ἐπι, and ἡμέρα) a name given to almanacs, from their containing matter for each day. In astronomy it is usual to call any table which assigns the place of a planet for a number of successive days an ephemeris of the planet. [ALMANAC.]

EPHESIANS, ST. PAUL'S EPISTLE TO THE, is the fifth, in numerical order, of the fourteen apostolical letters of St. Paul, contained in the canon of the New Testament. Throughout the primitive ages of Christianity it was regarded by the principal fathers as being of genuine and sacred authority. According to Dr. Lardner ('Credibility of Gosp. Hist.,' vol. ii.) the writings of Ignatius, who was St. Paul's contemporary, contain seven citations from this epistle. It is also cited by Irenæus, Clemens Alexandrinus, Tertullian, Origen, and many subsequent Christian writers. There were, however, several important and numerous sects, as the Nazarenes or Ebionites, and the Severians, Encratitæ and other followers of Tatian, who, in the 1st and 2nd centuries, denied both the genuineness and the authenticity of this and the other writings of St. Paul; rejecting them as a tissue of errors, and denouncing St. Paul himself as an apostate, and a perverter of the original system of Jesus of Nazareth. (Origen 'contra Celsum,' l. v.; Euseb. 'Eccles. Hist.,' l. iii., c. 21 and 27; Epiphanius, 'Hæres.,' 30; Hieron. 'in Math.,' c. 12; Nicephorus, 'Hist. Eccles.,' l. iv., c. 4, l. v., c. 12; Toland's 'Nazarenus,' p. 25-29.) A second epistle of St. Paul to the Ephesians is mentioned by Jerome ('De Scriptoribus Eccles.') and by Epiphanius ('Hom.' 42). The place and date generally assigned to this epistle by biblical critics are Rome, A.D. 61, that is, in the first year of the apostle's imprisonment at Rome (ch. iii. 1, ch. iv. 1, ch. vi. 20, and the postscript). Much has been written by commentators for and against the opinion that St. Paul addressed this letter to the Ephesians. The belief that it was so written is founded on the disputed reading of the words of the first verse, "to the saints at Ephesus" (ἐν Ἐφέσῳ), which appear in all the ancient manuscripts, and on the postscript which says, "written from Rome unto the Ephesians." This however is doubted and denied to be the fact by Grotius, Hammond, Mill, Wetstein, Paley, and Greswell, who adopt the statement, said by Tertullian to have been made by Marcion, that it was written to the Laodicæans. Macknight, Lardner, Hartwell Horne, Dr. W. L. Alexander, and Barnes (in his 'Commentaries'), see no difficulty in believing it to have been addressed to the Ephesians, and so far to establish the common opinion of the received reading of the introductory verse, addressing the epistle to "the saints in Ephesus." Of the same opinion is Dr. John Eadie, in his 'Commentary on the Greek Text of the Epistle of Paul to the Ephesians' (London, 1853); while Conybeare and Howison believe it was not addressed to the Ephesians. Archbishop Usher considered it a cyclical epistle addressed to no particular church, but to all, though Ephesus might have been the chief; and this opinion is advocated by Bengel, Michaelis and Hug. The style is exceedingly animated and fluent, and has less metaphorical obscurity than generally characterises the compositions of St. Paul; though from the length of the sentences, the number of members in each sentence, and the want of or imperfect punctuation, the original is often capable of more than one interpretation. It is also noticeable that, though St. Paul had resided so long, and was so well acquainted with the members of the church, in Ephesus, he addresses no one by name, but writes as if he were addressing persons unknown to him. The object appears to be to establish an earnest faith in the doctrines of Christianity, by giving exalted notions of their importance and moral excellence, and to encourage a perseverance in the Christian warfare with temporal and spiritual enemies. The first three chapters are occupied in especially setting forth the principles of predestinarianism (i. 4, 5, 11, iv. 30), and the last three are devoted chiefly to the enjoining of moral duties with respect to husbands, wives, parents, children, masters, and servants. "No real Christian," says Dr. Macknight, "can read the doctrinal part of this epistle without being impressed and roused by it, as by the sound of a trumpet." On the undesigned coincidences with the 'Acts' see Paley's 'Horæ Paulinæ.' The moral and doctrinal precepts of this epistle, with respect chiefly to election, have occasioned theological critics, especially those of Germany, to write elaborately on its proper interpretation.

E'PHORI (ἔφοροι), a body of magistrates at Sparta, who were possessed of great privileges. The institution of this office is usually ascribed to Theopompus, the grandson of Charilaus the Proclid, but from their being apparently placed among the institutions of Lycurgus by Herodotus (i. 65) and Xenophon ('de Rep. Lac.,' viii. 3) the office has been considered by some as a Dorian institution. Mr. Grote however ('History of Greece,' vol. ii.) contends that the institutions of Sparta were altogether peculiar to herself, and in no respect characterise the Dorians. Dr. Arnold supposes ('Thucyd.,' vol. i. p. 646) that the ephori, who were five in number, were coeval with the first settlement of the Dorians in Sparta, and were merely the municipal magistrates of the five hamlets which composed the city (see Müller, 'Dorians,' ii. p. 550, Engl. transl.); but that afterwards, when the Heraclidæ began to encroach upon the privileges of the other Dorians, and, it would seem, in the reign of Theopompus, who endeavoured to diminish the powers of the general assembly of the Spartan aristocracy, the Dorians, in the struggle which ensued, gained for the ephori an extension of authority which placed them virtually at the head of the state, although the nominal sovereignty was still left in the hands of the Heraclidæ. Thus the ephori were originally popular magistrates as far as the Spartans themselves were concerned, and were in fact the guardians of their rights from the encroachments of the kings, though they were in relation to the Periœci (περίοικοι) the oppressive instruments of an overbearing aristocracy, and formed in fact a close and unscrupulous oligarchy. (Plato, 'Legg.,' iv. p. 712 D.') The ephori were chosen in the autumn of every year; the first gave his name to the year; every Spartan was eligible to the office without any regard to age or wealth. They were empowered to fine whom they pleased, and exact immediate payment of the fine; they could suspend the functions of any other magistrate, and arrest and bring to trial even the kings. (Xenophon, 'de Rep. Laced.,' viii. 4.) They presided and put the vote in the public assemblies (Thucyd., i. 87) and performed all the functions of sovereignty in receiving and dismissing embassies (Xen. 'Hellen.,' ii. 13, 19), treating with foreign states (Herod., ix. 8), and sending out military expeditions. (Xen., 'Hellen.,' ii. 4, 29.) The king, when he commanded, was always attended by two of the ephori, who exercised a controlling power over his movements. (Herod., ix. 76.) The ephori were murdered on their seats of justice by Cleomenes III., and their office overthrown (Plutarch, 'Vit. Cleomen.,' c. viii.); but they were restored by Antigonus Doson and the Achæans in 222 B.C. (Polyb., ii. 70; Pausan., ii. 9, 2); and the office subsisted under the Roman dominion. When Lysander with the Spartan forces made himself master of Athens, B.C. 404, Ephori were appointed for that city, among whom were Critius and Theramenes, but these soon gave way to the domination of the thirty tyrants. (See Böckh, 'Corpus Inscriptionum,' i. p. 604-613.) On the ephoralty, the reader may consult Müller's 'Dorians,' book. iii.; Plass's 'Geschichte des alten Griechenlands,' vol. ii.; Tittmann's 'Darstellung der Griech. Staatsverfassungen;' and Grote's 'History of Greece,' vol. ii.

EPIC POETRY is that form of art which produces an imaginative description of external facts and occurrences, as distinguished from lyric poetry, which employs itself in registering, in an imaginative manner, all those internal facts and occurrences which go by the name of feelings and emotions.

Those who find this definition insufficient must remember that it does not and is not intended to apply to any single epic or lyric poem. With the exception, perhaps, of some of our old national romances, there does not exist an epic poem of any length which is perfectly free from lyrical passages; but this is no reason why we should confound the two forms of art, and not assign to poetry the one name or the other according to the proportion which it contains of either element.

From what we know of the operations of our own minds, and of the analogy which subsists between the growth of individual and national intellect, it appears most natural that epic should be the earliest species of poetry. A child, born into a crowd of circumstances all claiming his attention and exciting his interest, busies himself with the external world long before it ever occurs to him to examine what is going on within himself. Nay, more than this, his imagination, the idealising faculty, takes the models of its exertions entirely from the external world. His dreams, his reveries, his waking fancies, are active and epical, as any one who has watched the movements of children must acknowledge; but the time when he begins to notice his own thoughts and feelings—the lyrical age—does not come till later.

The earliest specimens of the epic form of art, which probably consisted of tales rhythmically arranged and recited to a very simple musical accompaniment, no doubt belonged to the unconscious era, during which the poet, setting before him no aim, or seeing it at best but very imperfectly, acts purely from the stirring impulse of his own imagination. Into this class we may perhaps admit some of our oldest and simplest romances; but the poetry of Homer and Hesiod, the twofold epic of the Greeks, cannot be denied to be, in great measure at least, the work of conscious artists. We shall notice the writings of the early Greeks first in order; and as it would swell this article to an unnecessary length were we to examine in detail the principal epic poems which we possess, we shall confine ourselves, in a great measure, to those which were composed during the periods both of ancient and modern history, when epic poetry could be said to be the poetry of the age, and leave those detached productions which owe their existence to the imagination of isolated men, in times long after the disappearance of the living epos, for a separate examination.

There are two divisions into which the epic poetry of the Greeks naturally falls; the heroic or romantic epos of Homer and of the Cyclic poets, and the hieratic epos of Hesiod. The attention of that age was centred, as ours is at present, on two grand ideas—the state and religion; whence we find a political and a hieratic epos. The 'Iliad' and 'Odyssey' are the two poems which remain as specimens of the former kind, and they are particularly worth the attention of all who are interested in the history of epic poetry, as they afford by far the most perfect instance of poems of that kind composed in an age differing but little in its characteristics from that to which they refer, and stand consequently in strong contrast to the 'Æneid,' a poem with which they are most frequently compared. The 'Æneid,' in common with most Latin poetry, depends more on beauty of language and arrangement than on anything in the story, exquisitely managed as it is, to excite the interest of its readers. As it traces the life of an individual, it stands in closer juxtaposition with the 'Odyssey' than with the 'Iliad;' but how superior is Ulysses to Æneas, and how much more romantic are the adventures of the Greek than those of the Trojan hero!

Perhaps there is not in the whole compass of literature a more perfectly drawn character than Ulysses, certainly none proceeding from so early a source. His touching exhibitions of feeling, the inimitable circumstantiality of the fictions which he spins in such profusion, apparently for no purpose except to confound his auditors; the manner in which all the interest of the story winds around him, the comic nature of the interludes, and the peculiarities attaching to the supernatural parts of his adventures, all unite to render the 'Odyssey' a poem more fitted perhaps than the 'Iliad' itself to interest an age like ours, when everything which gives a lyrical character to poetry is so much although so unconsciously sought for.

It usually happens that sacred poetry partakes strongly of a lyrical character, and Hesiod has perhaps struck out the only path which an epic writer in a simple age could follow without lapsing into the lyrical spirit as he approached theological subjects. The only poet of antiquity with whom he can be compared is Lucretius; but the 'De Rerum Naturâ' approaches so much more nearly to the character of a treatise on philosophy, that it is hard to give it the name of an epic poem, although it, as well as all didactic works like Virgil's 'Georgics,' come under the definition. The reason why we are slow to recognise them as epics arises from the habit of taking the heroic epos, one species, although the primary one, for the whole class, which really includes other species, as a reference to our definition cannot fail to show.

It has been observed by a German writer (Schelling, 'Vorlesungen,' &c., p. 224) that, properly speaking, an epic poem has no regular beginning or end; it is a metrical and imaginative production, which, if it consist of narrative, may take it up and lay it down at any period. This is the case with the Iliad, as well as with the Odyssey and Æneid, although the two last are considerably more complex in the arrangement of the narrative, and evidently draw to a more decided close than the Iliad. There appears, however, to be a greater unity in the plot of the Odyssey than in that of Virgil's poem, in this respect, that the events never get the upper hand of the hero. We are interested in his adventures because they are his; while in the Æneid they strike us rather as embellishments intended to possess independent merit.

The early romantic epos deserves notice as the first distinct form of modern art. Much discussion has been expended in order to ascertain whence arose those cycles of metrical romances which have for their subjects the exploits of Alexander the Great, King Arthur, and other heroes; but it rather concerns us here to notice that the second birth of civilisation which ensued on the breaking up of the Roman empire was productive of a series of events in literary history, parallel, as far as we can judge, to those which occurred in the times of Homer.

The traces of heroic poetry which remain in Livy's History are plain enough to enable us to infer with considerable probability that a series of epic poets appeared in Rome about the time of the Tarquins onwards; but as no fragments remain, we are too much in the dark as to the nature of their writings to enable us to refer to them as we do to Homer.

We find that the northern nations possessed numerous poems of an epical kind, some of which remain, and are or might be read with considerable interest. The cycles of romances on Troy and Alexander the Great compose a form of art which could only exist in a revival of imaginative spirit, as they derive their subjects from an older date and a different country, although, as regards every thing but the name of Greek or Trojan, the hero is usually the countryman of the bard; but the numerous poems on Arthur, with 'Havelok the Dane,' and 'Horn Child,' in our own language, 'Beowulf,' in Anglo-Saxon, 'The Poem of the Cid,' in Spanish, and the 'Nibelungen Lied,' in old German, are quite sufficient proofs of the coincidence of epic spirit with an early stage of society.

The Italian epic arose somewhat later than that of any of the northern nations, which may be attributed to the fact that it was only to a strong admixture of barbarian blood that the Italians owed their restoration to political existence. The dregs of a nation never possess a national literature.

Coleridge has observed that "Gothic art depends on a symbolical expression of the infinite," or what cannot be circumscribed within the limits of actual sensuous being, while in ancient art everything was finite and material. ('Lit. Remains,' vol. i. p. 68.) This applies more directly to architecture, but in a measure also to literature, although we think that the introduction of Christianity had more to do with it than the cause which Coleridge assigns, namely the wild liberty of the Northman's habits and manners and the imagery of nature which surrounded him. Perhaps the greatest difference which is traceable between the ancient and the modern epic has been produced by that spirit of devotion to the female sex which characterises all the Gothic nations; and arising as it does, partly from the refinement of an instinct and partly from religious impressions, is very superior, as a motive of action, to the mere unmitigated instinct for war which constitutes the prevailing feature of the ancient epic, or at least of the heroic poems.

We have been at no pains to notice those detached epic poems which have appeared at different times since the revival of learning, although some of the most noble specimens of this style of poetry are to be numbered amongst them; still less have we intended to give anything like sketches of any which we have mentioned, as this is properly done under the heads of the several authors, in Biog. Div.

(Thirlwall's *History of Greece*, vol. i.; Grote's *History of Greece*, vol. ii.; Mure's *Critical History of the Language and Literature of Ancient Greece*, vol. i.; Ulrici, *Geschichte der Hellenischen Dichtkunst*; Baehr, *Abriss der Römischen Literatur-Geschichte*.)

EPICHLORHYDRIN. [Chlorhydrin.]

EPICYCLE, a circle, the centre of which is carried round upon another circle: a term of the Ptolemaic System.

EPICYCLOID. [Trochoidal Curves.]

EPICYCLOIDAL TEETH OF WHEELS. [Wheels, Teeth of.]

EPIDEMIC (*ἐπιδήμιος, epidēmius*; from ἐπὶ, in the sense of "over" "all through," and *δῆμος*, "people") diseases are those which prevail among a large portion of the people of a country, rage for a certain time, and then gradually diminish and disappear, to return again at periods more or less remote. Thus cholera and influenza have prevailed as epidemic diseases in this country; and the continued fevers called synochus and typhus, and what are termed the eruptive fevers, as scarlet fever, the small-pox, the measles, frequently prevail as epidemics in different parts of the country. It is essential to the medical notion of an epidemic disease that it be dependent on some common and widely-extended cause, of a temporary in contradistinction to a persistent nature. [Endemic.]

EPIDERMOSE. [Fibrin.]

EPIGRAM (*'Επίγραμμα, Epigramma*; from the Greek ἐπὶ, *on*, and *γράφειν, write*), in its proper sense, is—a writing on—an inscription; whence it comes to signify a short poem, such as might be comprised within the limits of an inscription. For an account of the class of poems called epigrams by the Greeks, see Anthology; they are dedicatory, descriptive, amatory, elegiac; rarely humorous or satirical; and their merit consists "in the justness of a single thought, conveyed in harmonious language." (Preface to Bland and Merivale's 'Anthology.') Much of early Greek history was preserved in epigrams, to which Herodotus and Thucydides often refer; as for instance, those concerning the battle of Thermopylæ (Herod. vii. 228), one of which is thus literally translated: "Here once four thousand from Peloponnesus fought with three millions."

The Latin epigram approaches nearer to the English acceptation of the term, being much oftener dependent for its merit upon humour and personality. The most distinguished Latin epigrammatists are Catullus and Martial, in whom there is much wit, disfigured by much scurrility and obscenity; but many of the epigrams of Martial are epigrams in the Greek sense, and some of them are characterised by a propriety of thought and felicity of expression that could not easily be surpassed. The Latin Anthology of Peter Burman the younger contains a large collection of epigrams, by numerous authors, of which many resemble in simplicity the Greek epigrams.

In English the word signifies a short poem, which, to be good in its kind, must be clear, concise, and elegant in expression, and must contain a point, that is, some striking and unexpected turn of thought; whether it be humorous or serious is indifferent. The following terse and elegant compliment addressed by Pope to Lord Chesterfield, on being asked to write with that nobleman's pencil, may serve as well as any for a specimen:—

> Accept a miracle; instead of wit,
> See two dull lines by Stanhope's pencil writ.

EPILEPSY, *Epilepsis* (ἐπιληψις), 'a seizing.' Synonymes: *Morbus divinus, herculeus, comitialis, caducus; Falling Sickness.* Sudden abolition of sensation and consciousness, with convulsions [Convulsion] of the muscles of voluntary motion, ending in a state of sopor or apparent sleep, the attack recurring in paroxysms more or less regular. The attack of epilepsy is usually quite sudden. The person, while in his ordinary health, and perhaps engaged in his usual occupation, utters a piercing scream. If standing, he falls to the ground, where he lies for a moment in a state of extreme rigidity, almost amounting to tetanic stiffness; but this state is quickly succeeded by convulsions, which variously agitate the limbs and the trunk of the body. The head is generally thrown backwards; the eyes are open, fixed and staring; the pupils are dilated; the vessels of the head and neck are swollen, rendering the countenance flushed, and sometimes of a dusky hue; the muscles of the face are in violent action, producing frightful distortions of the countenance; the muscles that move the lower jaw close the mouth with violence, producing gnashing of the teeth; the tongue, which is swollen and livid, is thrust out forcibly between the teeth, and is often grievously wounded; the arms are sometimes tossed violently about the chest, or struck against it; the hands and fingers are in a state of rapid alternation, between the motions of flexion and extension; the lower extremities are agitated in a similar manner; the thumbs are drawn inwards, and the toes incurved: and a quantity of frothy saliva flows from the mouth, which is often bloody from the wounds inflicted on the tongue. The muscles on one side of the body are commonly more violently agitated than those of the other. Several cases are on record in which the muscular contractions were so violent that the bones of the limbs were broken, the teeth fractured, and the joints dislocated. Generally the convulsions have for a few moments some remission, when they are again suddenly renewed with great violence. The breathing is disordered in consequence of the convulsion of the muscles of respiration. At first heavy and difficult as if a load were placed upon the chest, it becomes at length quick, short, irregular, and stertorous, and is often accompanied with sighing and moaning. The diaphragm, the muscles of the abdomen, and the muscular fibres of the bladder, contract with so much violence that the fæces and the urine are discharged involuntarily and with great force.

The pulse, always difficult to be felt, is commonly quick and small but it becomes distinct towards the end of the paroxysm, and is then more slow and languid. The action of the heart is irregular, tumultuous, and loud, and the carotids throb vehemently. After the contractions of the muscles have continued for some time the convulsions diminish in violence, and at length cease altogether. Perspiration breaks out about the head, neck, and breast; the convulsive respiration is followed by sighs, and the spasms of the muscles by subsultus. The patient is now restored to a slight degree of consciousness; but, as if exhausted by the violence of the struggle, he soon sinks again into a state of profound insensibility, and lies in a deep sleep. During the state of sleep, the perspiration becomes copious and general over the whole body; the pulse fuller, softer, and slower, and the respiration freer and easier. After a time the person awakes, sometimes suddenly, but in general it is only by degrees that sensation, consciousness, and the power of motion return. Commonly there is no consciousness whatever of anything that has passed during the paroxysm. On coming out of the fit there is generally headache, and always languor. The convulsive stage may last from one or two minutes to fifteen or twenty, and the sleep from one to several hours. The duration of the whole paroxysm is generally from five to ten minutes; but often two or three attacks follow each other in such rapid succession, that the paroxysm seems to be protracted for several hours. Occasionally death takes place unexpectedly in the midst of the fit, either in consequence of injury inflicted on the brain by congestion of the cerebral blood-vessels, or by the suspension of the respiration through the spasm of the muscles of the larynx, which close the opening of the glottis so completely and for so long a time as to induce the state of asphyxia.

Such are the general circumstances which accompany an epileptic attack, and the general form of the disease is pretty much the same in all the persons afflicted by it; the chief difference is in the slightness or severity of the phenomena, in which there is every possible variety, from an attack so severe as to produce instantaneous death to one which is so slight that it can scarcely be perceived. Sometimes, for example, instead of the regular and violent fit just described, the seizure consists merely of loss of consciousness, slight rigidity, spasms or convulsions of a few muscles or of a single limb, the attack lasting only a minute or two. At other times the patient is seized with sickness or a sensation of faintness, the sight becomes dim, the recollection imperfect, and the power of voluntary motion so far impaired, that the person slips from his chair, or falls from his horse, and lies on the ground insensible, pale, perspiring, but without convulsions. Or the attack may be so slight that consciousness is not wholly lost; but the mind becomes confused, the power of articulation suddenly diminished, and instead of finishing the sentence he was uttering, the person continues to mumble for half a minute or a minute the last words he was attempting to speak, in a slow, monotonous, gibbering manner; and then recovering, he takes up the thread of his discourse, being soon aware of an interruption of consciousness, which interruption there is often an effort to conceal. This state is described by the persons subject to it as one of great mental distress and depression, like a frightful dream: they feel perplexed and afflicted by an imperfect reminiscence of some overwhelming calamity, or a sense of remorse for which they cannot assign a cause. A paroxysm of this kind is like a short mood of extreme melancholy, and such is the impression that the countenance of the patient, which is full of sadness, makes upon the spectator. These slighter paroxysms may recur only at very distant intervals; but they more commonly return often, and sometimes three or four times a day.

The return of the regular epileptic paroxysm is exceedingly various in different individuals. Several years may intervene between the seizures; or they may recur once every month, week, or day. It is stated that they sometimes recur periodically, and with remarkable exactness to the very day; once a year, or once a month. When they recur monthly, and observe a stated day, that day sometimes coincides with the new or full moon, a coincidence to which great importance was attached in former times. The interval of a lunar month is more commonly noticed among females, from the connexion of the disease with the uterine functions. In some instances, the paroxysms occur every week, on the same day; and occasionally every day, or night, at the same hour; but they most frequently come on when first falling asleep, and are often for a time unsuspected or overlooked. Sometimes several slight seizures take place in one day; but their recurrence is often extremely irregular. When they are neglected, they usually either become more and more severe, or occur after shorter intervals. Consciousness and sensation being abolished, pain cannot be felt during the fit.

Though the epileptic attack usually comes on suddenly, yet it sometimes gives distinct warning of its approach. The symptoms premonitory of an epileptic fit are analogous to those which precede an attack of apoplexy [APOPLEXY], namely, headache, giddiness, flushing of the face, throbbing of the temples, drowsiness, sense of weight or heaviness of the head; flashes of light before the eyes, sleeplessness, fretfulness, irritability, or unusual cheerfulness and hilarity; disorders of the digestive organs, as voracious appetite, sickness, vomiting, constipation, or diarrhœa. But there is one peculiar sensation, termed the *aura epileptica*, of which many epileptics are conscious immediately before the fit. This consists of a feeling as if something were moving in some part of the limbs, or trunk of the body, and creeping thence upwards towards the head. Sometimes it is described as a sensation of a current of air, a stream of water, or a slight convulsive tremor; at other times no distinct idea can be given of the feeling further than that it is a sensation of something moving along. This remarkable sensation does not appear to follow very distinctly the course of a nerve, but it seems to pass along the integuments. When it reaches the head, the patient is instantaneously deprived of sense, and falls down in convulsions. The sensation arises in different parts of the body, in the toe, foot, leg, and groin; in the finger, hand, and arm; at the bottom of the spine; in the uterus, loins, abdomen, and chest. But, in the great majority of cases, the attack of epilepsy is preceded by no such warning; and even where the premonitory symptoms do exist, the attack does not by any means always follow.

Epilepsy rarely occurs in a person otherwise in sound health. Out of three hundred cases, the early history of each of which was carefully investigated, very few had been perfectly well previously to the accession of the disease. Convulsions during the first dentition, eruptions on the skin, mental excitement, diseases of the glands, chorea, hysteria, tremor, cramp, vertigo, palpitation, headache, flushing, bleeding from the nose, precede the first epileptic attack, and perhaps may be considered, at least in part, as predisposing causes of the malady.

As this disease is often long preceded by other maladies before the actual seizure, so, after it has subsisted for some time, it induces a peculiar state of the constitution, and more especially, it would appear, in the nervous system, which predisposes to the recurrence of the attack, and the signs of which internal state are manifest in a peculiar expression of the external features. The eyelids become swollen: the eyes prominent and unsteady; the look vacant; the cheeks pale, the lips thick; and the individual features, however originally beautiful, grow coarse, and lose their fine expression. The steadiness and energy of the mind progressively diminish; the purpose becomes irresolute, and the power of continuous application for the accomplishment of a given object is lost. Instances are recorded in which, though the disease recurred frequently for a long series of years, neither the memory nor any other mental faculty appeared to be impaired; but this is exceedingly rare.

"Of 298 epileptics in the Salpêtrière, in 1813, 80 were maniacal, and 56 in various states of mental alienation and imbecility. In 1822, out of 339 cases in the same hospital there were 2 monomaniacs, 30 maniacs, 34 furious maniacs, 129 insane for some time after the paroxysms, 16 constantly insane, 8 idiotic, 50 upon the whole reasonable, but with impaired memories, and liable to occasional slight delirium and tendency to insanity, and 60 without aberration of intellect, but irascible, capricious, obstinate, and presenting something singular in their characters." A very common termination of epilepsy is apoplexy or paralysis.

Authors commonly divide epilepsy into two species: first, idiopathic, where the disease depends on some primary affection of the brain, and, secondly, sympathic, in which it depends on an affection of some remote part, as the stomach, the liver, the bowels, the generative organs, the circulating system, &c.

The state of the brain on which epilepsy depends is unknown. Dissection shows that the brain of the epileptic is seldom sound; but much as this subject has been investigated, little light has hitherto been shed upon the pathology of the brain as connected with this disease. The most common morbid appearance are the thickening of the bones of the skull; spiculæ or morbid growths of the bone from the inner table of the skull; vascular turgescence, or inflammation of the membranes of the brain; preternatural hardness or softening of the substance of the brain and of the spinal cord; effusions of serum, blood, jelly, or pus between the membranes, upon the surface or into the ventricles of the brain; tumors or morbid growths in its substance; adventitious deposits, as tubercles, or parasitic animals, as hydatids. Recent researches appear to indicate that the parts of the brain which most commonly undergo morbid changes of structure in this disease are the parts more immediately in the neighbourhood of the sphenoid bone, and especially the pineal and the pituitary glands, and particularly the latter. But occasionally, where violent epilepsy has existed during life, the most careful examination of the brain after death has led to the discovery of no appreciable change in its structure; while even the morbid appearances which are manifest are often observed to be present without being accompanied with epilepsy; so that the relation between any known morbid change in the structure of the brain and epilepsy is not yet certainly established. It follows, as has been stated, that nothing is really known of that condition of the brain which causes epilepsy.

But many of the causes of the malady are well ascertained, and the knowledge of these is of great importance in the prevention and cure of the disease. It is conceived that there is a constitutional predisposition to epilepsy, although it does not seem easy to assign with exactness in what this predisposition consists. Several of the exciting causes are weak impressions which are applied to most persons with little or no effect.

The exciting causes consist of two classes, those which act by exciting the energies of the brain, and those which act by depressing the brain. Those which act by over-stimulating the brain are mechanical, chemical, and mental stimulants, and the peculiar stimulus of over-distention; as sharp-pointed ossifications, arising either from the internal surface of the cranium or formed in the membranes of the brain; powerful mental emotions, such as joy and anger; congestion of the blood-vessels of the brain; suppressed discharges; violent exercise; too large a quantity of highly nutritious food or of stimulating drink. "I have observed," says Fothergill, "that epileptics are often extremely incautious with respect to diet; that children highly indulged are liable to the disease; that in every other period of juvenescence, and in middle-aged adults, if they were attacked with the disease, it was when they had either committed some excesses or by one means or another were plethoric, and that in habits subject to epilepsy, the disease seldom recurred without either an habitual indulgence in eating or a neglect of necessary exercise."

But the very opposite causes, those which manifestly weaken the energy of the brain, occur in epilepsy, as hemorrhage, whether spontaneous or artificial; terror, horror, disgust; any powerful and disagreeable sensations, and especially certain disagreeable odours; excessive evacuations, great fatigue, inanition, and sedative poisons.

The medical treatment of a case of epilepsy must of course differ essentially according as it is idiopathic or sympathic, and connected with a plethoric and robust, or debilitated and exhausted state of the system. Unless he previously ascertain the condition of the brain and spinal cord, or the nature of the affection of the remote organ in sympathy with which the brain is suffering, the practitioner must work entirely in the dark, and must be liable to adopt the very opposite course of treatment to that which the case really requires. When the appropriate remedies are judiciously employed, and the proper regimen is strictly adhered to, epilepsy is often permanently cured, and the suffering is greatly mitigated even in those forms of the disease which do not admit of cure. Dr. Cheyne has laid down some excellent rules for the management of epileptic patients, of which, as they are of a popular nature, and applicable to the great majority of cases, we give the substance.

In prescribing a rule of diet suitable to all epileptics, moderation in quantity and simplicity in the preparation of the food are indispensable points. The diet best calculated to preserve an individual liable to scrofula from an attack of that disease is best suited to a patient liable to epilepsy. Fermented liquors should in general be altogether withheld. Flesh-meat ought to form the principal part of one if not two meals in the day; and milk, if it do not retard digestion, which it is less liable to do when fermented liquors are laid aside, is the article next in value. The epileptic ought to be trained so as to be in good wind, so as to put his muscles in a state of the utmost strength and firmness. Epileptics should be put under a regular course of training like the athletæ of ancient, and the gentlemen of the fancy in modern times. When the patient leaves his bed in the morning, he may have a rusk or a slice of toasted bread with an egg beat up in a teacup full of warm water; then let him dress, make all needful arrangements, and walk three or four miles. Two hours or more after he has left his bed, let him have his second meal, milk or cream in water, or cocoa with bread a day old and butter. Rest for three hours after breakfast. This will be the best time to devote to business or education. Then he must again walk, if an adult possessed of sufficient vigour, from five to eight miles. At from five to six hours after his second meal, let him have a third, consisting of meat of the best quality, mutton, poultry, game, or very tender beef, roasted or boiled, of which an adult must not eat more than six ounces; bread, and one moderate helping of tender well-boiled vegetables; of drink, not more than a common tumbler full of distilled water, Seltzer water, with a little milk, or toast and water. Then rest for two hours; that is, stroll in a garden, read an amusing book, or engage in any occupation which will not raise the pulse by one beat; then resume more active exercise for an hour or two. In five or six hours after dinner, a light supper may be taken, consisting of not more than four ounces of meat with bread, or of a cup of milk with a water biscuit. The rest of the evening may be spent in cheerful society, in a large airy room, not over lighted nor over heated, but sufficiently warm to prevent that chill which in the latter part of the day often follows very active exercise; and every occupation by which the mind is depressed or is excited, and thereby subsequently exhausted, must be avoided. The patient must be in bed at eleven and up at six, nothing in general being more hurtful to epileptics than sleep unnecessarily prolonged.

The scalp in all epileptics ought to be shaved once a week, and daily well rubbed with a flesh-brush after the tepid shower bath, or what answers nearly as well, after pouring a flagon of tepid water on the head inclined over a large basin. The patient may gradually bring himself to sleep without a night-cap and without curtains, with the shoulders and head raised and the feet well protected from the cold, in a chamber as large and airy as possible and without a fire.

A patient liable to epilepsy must not be permitted to ride nor to hold the reins in a carriage. The grates in all the apartments which he frequents ought to be guarded by a deep and strong fender; he ought to avoid the streets of a crowded city, in which the whirl of carriages, the tide of human beings, and the multiplicity and distraction of objects produce a vertiginous hurry of thought, which to him is ever dangerous. He ought not to walk near water. A fine young man of twenty came to an untimely end in his own garden, by falling into a runnel, in which he was drowned, although the water was not more than four inches deep.

If an attack of the disease come on while the patient is in his chamber, he ought immediately to be laid on his back on a bed, with an attendant standing on each side to prevent him from injury during the struggle. If he is much flushed, his head and shoulders ought to be elevated, the warmth of his extremities supported, while at the same time air is freely admitted into the room. All attempts to make him swallow or to stimulate the nostrils are improper. A medical practitioner ought to be sent for, and ought to remain in attendance while the struggle lasts. In a first attack, if the fit is severe, blood ought to be procured from the temporal artery, a precaution which will also be necessary in patients of an apoplectic diethesis whensoever they labour under a prolonged fit of apoplexy.

(Cheyne, *Cyclopæd. of Pract. Med.*; Copland, *Dict. of Pract. Med.*; Prichard, *Diseases of the Nervous System*; Cooke, *Hist. and Method of Cure of the various Species of Epilepsy.*)

EPILOGUE (*ἐπίλογος, epilogus*) compounded of *ἐπὶ, on* or *after*, and *λόγος, speech*) signifies, in Greek, a summing up, the end or peroration of a discourse. In English it is applied to the short poems or copies of verses, or to the short prose address which formerly were commonly subjoined to new plays, and recited on the stage at their conclusion. An epilogue is usually written in a lively tone, with such allusions to the play, the author's circumstances, the news or fashions of the day, or other subjects of existing interest, as are thought likely to conciliate favour and send the audience away in good humour. "If it be true that good wine needs no bush, 'tis true that a good play needs no epilogue: yet to good wine they use good bushes, and good plays prove the better by the help of good epilogues." ('As You Like It.')

EPIPHANY, from the Greek Ἐπιφάνεια (*Epiphaneia*), appearance, or manifestation, a church festival, celebrated on the twelfth day after Christmas, in commemoration of our Saviour's being manifested to the world by the appearance of a miraculous star; likewise denominated Twelfth Day. This day is said to have been first observed as a separate feast in the year 813. The customs of this day, though various in different countries, all agree in the same end, namely, to do honour to the eastern magi, or kings, who visited and made offerings to our Saviour at his birth.

EPIPOLIC DISPERSION OF LIGHT. [DISPERSION.]

EPISCOPACY. [BISHOP.]

EPISODE (*ἐπεισόδος, epeisodos*). The Greek word *eisodos*, the principal member of this compound, when applied to the drama, means an entrance of the chorus on the stage; *epeisódion*, that part of a play which lies between two choral songs; and as these recitations had, in the rude beginning of the Greek drama, no connection with the choral part, which they were introduced to relieve, the word, with its derivative Latin form, comes to signify a thing connected with, but not essential to, that of which it is part,—which may be taken out and leave a perfect work; as, for instance, the Catalogue of Ships, in the 'Iliad,' or the War in Heaven, in 'Paradise Lost.' Episodes should grow naturally out of the subject; and when judiciously used, they relieve and diversify the main narration. But they should be sparingly introduced, so as not to create confusion. In the 'Orlando Furioso,' for instance, or the 'Fairy Queen,' the episodes are so many and so long, that the whole resembles a set of detached legends inartificially patched together, rather than a single poem pervaded by one intention. Episodes are commonly the most highly-finished portions, since their shortness warrants a degree of elaboration and ornament which could hardly be maintained through a long composition, and indeed might be wearisome if it could.

EPISPACTICS. [BLISTERS.]

EPISTAXIS (from *ἐπίσταξις*, a dropping, bleeding of the nose) is the term used by most nosologists to indicate bleeding from the nose, which essentially consists in an effusion of blood externally from the pituitary membrane. There are few parts of the body more liable to hæmorrhage than the lining membrane of the nose. The blood-vessels which supply this membrane are branches of the common carotid arteries, and the blood is returned from the membrane by veins which join the external jugular veins. Blood may flow from the nose under very varying circumstances; sometimes when the system is in a state of plethora, and at others when in a state of debility. When it occurs in plethoric persons it is usually preceded by pain in the head, vertigo or drowsiness, frightful dreams, increased heat of one side of the face, injection of the eyes, flashes of light before the eyes, increased beating of the temporal arteries, deafness, &c. These symptoms will be present, more or less intense, according to the general condition of the sufferer. This active form of the hæmorrhage comes on in the course of many diseases, as the inflammatory forms of fever, inflammation of the brain, lungs, &c. Where the bleeding comes on in a state of debility it is called passive, and may make its appearance without any premonitory symptoms. This form comes on in the course of low and malignant fevers, and various diseases which come on in a cachectic state of the body.

Bleeding at the nose, when it occurs alone, most frequently comes on in children. After ten or twelve years of age it is oftener seen in boys than girls. It is frequently hereditary, and whole families exist who are liable on slight causes to bleed at the nose. It may be brought on by whatever increases the flow of blood to, or retards the flow of blood from, the head. Thus, mental excitement, anger, shame, protracted study, stooping, sneezing, deep sighing, hallooing, singing, coughing, tumors on the veins, tight neckcloths, &c., may all be exciting causes of the bleeding. Whatever causes absolute or relative plethora, as too free living, the suppresion of accustomed discharges, whatever interferes with the free circulation of the blood, as tight clothes, whatever determines the blood to the surface of the body, as diminished pressure of the atmosphere, as in ascending mountains, a highly heated atmosphere, &c., will also produce it.

Bleeding at the nose is not in itself a dangerous disease. It may, however, come on in states of the body when the system is already exhausted, and be the forerunner of a fatal result. But in inflammatory diseases, and where the person is plethoric, it is frequently a relief to the system, and is followed by a diminution of painful symptoms. In persons, however, after middle age, and who are inclined to plethora, this symptom should be looked upon as indicative of congestion, which may proceed further, and the warning should be regarded, and a diminution in the indulgences of the table insisted on.

In the treatment of bleeding from the nose, regard must be had to the state, age, &c., of the patient. When it occurs in children, and in the great majority of simple cases, all that is required is to make the patient assume the sitting posture, and hold the head backwards; cold should be applied to the face, and a piece of cold metal placed between the nape of the neck and the clothes. Acid drinks may be given at the same time. When the person is plethoric and has suffered much pain in the head, singing in the ears, &c., previously, it will not be adviseable to stop the bleeding until these symptoms are relieved. This may be followed by the exhibition of purgatives; and bleeding from the arm should be had recourse to if the head symptoms continue. When the bleeding follows the stoppage of any natural discharge, this latter should be restored. Cupping on the nape of the neck, or even dry cupping, may be recommended in these cases. But in the passive states of the system it is frequently desirable to avert the bleeding without loss of time. Under these circumstances astringents should be applied immediately to the pituitary membrane. A solution of the acetate of lead, of the sulphate of zinc, of iron, of copper, or of alum, may be injected up the nostrils, or a dossil of lint wetted with the solution thrust up the nostril. Tannin or tannic acid may be employed in the same manner. These astringents may also be administered internally with small doses of opium. One of the most effectual means of arresting hæmorrhage from the nose when other means fail is plugging the posterior nares, which may be done by introducing a piece of sponge or lint upon a ligature into the mouth, and carrying it through the nares to the nostril in front. This generally exercises sufficient pressure to arrest the bleeding.

(Copland, *Dictionary of Medicine; Cyclopædia of Practical Medicine*, article Epistaxis.)

EPISTYLE, the first layer of stone placed on columns to form the architrave. The term is derived from the Greek epistylium (ἐπιστύλιον), and that from the words *epi*, (ἐπὶ) 'upon' and *stylus*, (στῦλος), 'a column.'

EPITAPH (ἐπιτάφιον, *epitáphium*), an inscription on a tomb; from ἐπὶ, upon and τάφος, a sepulchre. Inscriptions in honour of the dead are perhaps as old as tombs themselves; the most ancient however with which we are now acquainted are probably those of Simonides up[illegible] Megistias the soothsayer of the little army of Leonidas, and on the heroes who fell at Thermopylæ, preserved by Herodotus. (vii. 228.) Another epitaph of very high antiquity may be referred to in the ancient Greek inscriptions found in the Ceramicus at Athens, upon the warriors who fell at Potidæa 432 years B.C. The original, in a mutilated state, is among the Elgin marbles in the British Museum. (No. 348.) The reader will find other examples of Greek and Roman epitaphs in the Elgin and Townley marbles of the British Museum, published under the superintendence of the Society for the Diffusion of Useful Knowledge.

The earliest epitaphs of this country were those of the Romans or Romanized Britons, which usually began with D. M. (*Diis Manibus*), followed by the name, office, and age of the deceased, and a conclusion which informed the reader by whom or through what means the inscription was erected. This seems to have been the ordinary formula of the sepulchral inscriptions of that period.

Whether the Saxons or the Danes used monumental inscriptions among us, either in their own or in the Latin tongue, has been doubted. The few which we have for people of the Saxon times are the compositions of a later date. Three or four small slabs, however, bearing crosses and some female names, supposed to be those of nuns, were dug up at Hartlepool.

The regular series of English epitaphs begins in the 11th century, when they were still written in the Latin language. One of the most remarkable of this period is that preserved in Sir William Dugdale's Baronage, for William de Warren, earl of Surrey, who died in 1089, copied from the abbey register of St. Pancras, Lewes, of which he was the founder, where it is said to have been engraven on white marble.

Hic Gulielme Comes locus est laudis tibi fomes
Hujus fundator, & largus sedis amator.
Iste tuum funus decorat, placuit quia munus
Pauperibus Christi, quod prompta mente dedisti.
Ille tuos cineres servat Pancratius hæres,
Sanctorum castris qui te sociabit in astris.
Optime Pancratie, fer opem te glorificanti;
Daque poli sedem, talem tibi qui dedit sedem.

A mutilated epitaph for Gundreda, daughter of William the Conqueror, and wife of this earl of Surrey, is still remaining in the church of Southover near Lewes; she died in child-bed in 1085. The generality, however, of the epitaphs of this period are neither so long nor so laboured as the earl of Surrey's. Vitalis, the twenty-first abbot of Westminster, who died in 1082, had only these lines—

A vita nomen qui traxit, morte vocante,
Abbas Vitalis transiit, hicque jacet.

In the 12th century our epitaphs are few. The tomb usually consisted of a single figure; and the inscription added to it was little more than a mere designation of the person: such as that at Hereford, of the year 1148,

Dominus Robertus de Retum episcopus Herefordensis;

or that in the chapter-house at Gloucester, 1176,

Hic jacet Ricardus Strongbow, filius Gilberti Comitis de Pembroke.

Early in the 13th century we begin to find the epitaph in French, occasionally accompanied by promises of absolution to such of those who passed the tomb as might pray for the soul of the deceased. Weever gives an instance of this in his 'Funeral Monuments,' in an inscription for Robert the third earl of Oxford, who died in 1221:—

Sire Robert de Veer le premier Count de
Oxenford le tierz git icy. Dieu de l'ame si lui
Plest face merci. Ki pur l'alme priera XL
Jors de pardon avera. + Pater noster, &c.

At the church of Kingswear, in Devonshire, we have an epitaph of this kind in rhyme:—

Vos qui ici venez
Pur l'alme Philip priez.
Trente jours de pardon
Serra vostre gwerdon.

Henry III.'s epitaph, in the same language, with a prayer for mercy to him, still remains embossed in old capitals round the ledge of his tomb in Westminster Abbey, 1272.

The epitaph in French continued till the middle of the 14th century, after which time inscriptions in the vernacular tongue became common. One of the earliest, perhaps, was that upon a stone over one of the Savile family at Thornhill, in Yorkshire:—

Bonys emongq stongs lys ful
steyl, gwylste the sawle wan-
deris were that God wylethe.

Blomfield, in his 'History of Norfolk,' has preserved a curious specimen of the English of the time, in an epitaph from Holm Church in that county, about 1404:—

Henry Notingham and his wyff lyn here
That mayden this church, stepull, and quere,
Two vestments and bellez they made also,
Christ them save therefore fro wo!
And to bringe ther soules to bles of heven
Saith Pater and Ave with mylde steven.

Gough, in his 'Sepulchral Monuments,' whence much of our information has been obtained, gives the following from the church of St. Peter at St. Albans, 1420:—

In the yere of Christ on thousand and four hundryd ful trew with four and
sixteene
I Richard Skipwith gentylman in birth late fellow of New Inne,
In my age twenti on my sowl partyd from the body in August the 16th day
And now I ly her abyding God's mercy under this ston in clay,
Desyring yow that this sal see unto the Meyden pray for mee
That bare both God and Man,
Like as ye wold that other for ye shold
When ye ne may nor can.

The clergy and religious, however, still preferred Latin, perhaps, as their more familiar idiom; and one or two instances occur, even so late as the middle of the 15th century, where the epitaph is given in Latin rhyme. The last edition of Hutchins's 'Dorsetshire' mentions the following as engraved round the arch of the church door at Durweston, near Blandford, 1459:—

Hic jacet sub tumulo Downton Willielmus humatus:
Rector erat villæ Durweston: Okfordie natus.

The generality of the Latin epitaphs of this period were on strips of brass, and began most frequently with *orate pro anima*, perhaps followed by *miserrimi peccatoris;* an address, says Dr. Johnson, to the last degree striking and solemn, as it flowed naturally from the religion then believed, and awakened in the reader sentiments of benevolence for the deceased, and of concern for his own happiness. There was nothing trifling or ludicrous, nothing that did not tend to the propagation of piety and the increase of devotion.

With the reformation of religion this ceased. The reign of Elizabeth affords but few instances to the contrary; though it is singular that two occur beginning "pray for the soul," upon monuments at Stanton Harcourt, in Oxfordshire, one dated 1566, the other 1569.

After this period the diffusion of learning gave a classic turn even to the epitaph; and though the reigns of Elizabeth and James I. can furnish but few of a pure standard, there is one of Ben Jonson's on the Countess of Pembroke which scarcely yields to any in the Anthologia:—

Underneath this sable hearse
Lies the subject of all verse:
Sidney's sister, Pembroke's mother.
Death, ere thou canst find another,
Good, and fair, and wise as she,
Time shall throw a dart at thee.

The epitaph on Sir Christopher Wren need hardly be repeated, though it is said to have been borrowed. In real merit it is probably surpassed by the latter part of that in King's College Chapel, Cambridge, over the resting-place of Thomas Crouch:—

Aperiet Deus tumulos; et educet
Nos de sepulchris.
Qualis eram, dies isthæc cum
Venerit, scies.

Wit and humour have also marked the composition of the epitaph in almost all ages. Innumerable instances will be found in all the printed collections. Margaret of Austria composed for herself the following couplet, when in imminent danger of shipwreck:—

Cy gist Margôt, noble demoiselle,
Deux fois mariée, et morte pucelle.

Collections of epitaphs, ancient and modern, are numerous; there are many of great merit in the Greek Anthologia. A very large collection of epitaphs will be found in 'Theatrum Funebre, exhibens per varias scenas Epitaphia nova, antiqua, seria, jocosa, &c., in quatuor partes distinctum, extructum a Dodone Richea (seu Ottone Aicher),' 4 to, Salisburgi, 1675; Hacket's 'Select and Remarkable Epitaphs on Illustrious and other Persons,' 2 vols. 8vo, 1757: and Le Neve's 'Monumenta Anglicana,' probably preserve the best English collections. Many curious and interesting epitaphs will be found in the volumes of 'Notes and Queries' for 1858, and preceding years. The Society of Antiquaries in June, 1858, invited the contribution from all quarters of authentic copies of monumental inscriptions, with a view to their preservation, and probably publication.

The funeral orations of the Greeks were called by the name of *Lógos Epitáphios* (Λόγος Ἐπιτάφιος), or a discourse over the tomb made at the time of interment. It is only necessary to mention this to prevent any confusion of this kind of epitaph with that which is the subject of the present article.

EPITHALA'MIUM (ἐπιθαλάμιον, from ἐπὶ, "at" or "near," and θάλαμος, "chamber," especially that of a new-married couple), a poem composed in honour of a marriage. It was sung by youths and maidens conjointly, at the door of the bridal chamber, after the bride and bridegroom had entered, and also before they rose in the morning. The first Greek epithalamium known to have been written was a poem by Hesiod, now lost, on the marriage of Thetis and Peleus. The most remarkable extant are those of Catullus, who has left three beautiful specimens of this sort of composition. The first, on the marriage of Julia and Torquatus, is the most curious and interesting as an illustration of manners. That on the marriage of Peleus and Thetis, which is probably only a fragment, is one of the most beautiful extant specimens of Latin poetry. Among the Hebrews, as well as the Greeks and Romans, this species of rejoicing was in use. The subject is hardly in accordance with modern manners. Spenser has treated it beautifully and delicately in his Prothalamium and Epithalamium on the marriage of the Ladies Somerset. Many other English specimens may be found, especially among the writers of the 17th century: but we know of none remarkable enough to require notice.

EPOCH. (Astronomy.) This term is frequently applied to signify, not a moment of time, but the longitude which a planet has at that moment of time. In order to predict the longitude of a planet at any epoch, some preceding epoch must be taken, at which the longitude is known. This latter is called, *par excellence*, the epoch; and the term longitude at the epoch has been abbreviated into epoch.

EPOCH, in chronology. [ÆRA.]

EPODE (in Greek ἐπῳδὸς, *after-song*, from ἐπὶ, "on" or "upon," and ᾠδὴ, "song") is one of the three divisions of the Greek ode. [CHORUS.] The performers in singing it stood still; it was not, like the strophe and antistrophe, symmetrical with another member of the ode; so that the poem was unfettered as to its length and as to the choice of measures. The epode, however, is not essential to an ode; many of the Greek choruses have none. Most of Pindar's odes, on the contrary, have an epode interposed between each antistrophe and the following strophe. Epode, according to the grammarians, is also a metrical term given to those measures in which a short verse follows a long one, of which the former is called *proodic*, the latter *epodic*. Hence the fifth book of Horace's Odes is called the Book of Epodes, because nearly all of them are written in that sort of measure: as, for instance,—

"Ibis Liburnis inter alta navium,
Amice, propugnacula."

EPROUVETTE is an apparatus for determining the strength of gunpowder. Eprouvettes are of two kinds: the gun eprouvette, which gives the strength by the length of recoil; and the mortar eprouvette, which gives it by the distance an accurately turned heavy ball is thrown by a small charge of powder. Mr. Robins ('New Principles of Gunnery') first proposed the employment of such a machine; but Dr. Hutton, of Woolwich, afterwards considerably improved its construction.

The gun is fixed near its centre of gravity to the lower extremity of an iron rod, which may be about 7 feet 6 inches long, and its base is attached by a short brace to an arm which projects from the rod, an adjusting screw being provided for the purpose of keeping the axis of the bore perpendicular to the same rod. Sometimes, however, a frame of iron, like the letter A, serves to suspend the gun, which is then fixed at two places in collars at the lower extremities of the frame. To the upper part of the rod or frame is attached a horizontal axle of steel, about which the gun is to vibrate; and each extremity of this axle rests in a socket at or near the top of the frame which constitutes the stand or support of the gun and its suspending apparatus.

From the lower side of the gun projects downwards a rod or style of iron, which is pointed at its lower extremity, the point being in a line drawn from the middle of the horizontal axis of suspension through the centre of gravity of the gun. Under the latter, and resting on the ground, is a block of wood, in the under surface of which is cut a groove, in a vertical plane, in the form of a portion of a circle whose centre is at the middle of the axis of suspension; and this groove being filled with soft wax, the point of the rod projecting below the gun, in the recoil of the latter, scratches on the wax a circular arc: the measure of this arc gives, of course, the angle of the recoil.

Instead of this pointed rod and grooved block, a quadrant of brass of any convenient radius, as 12 inches, is sometimes fixed in a vertical position to the rod or frame which carries the gun, the horizontal axis of suspension passing through its centre; the quadrant, whose arc is graduated, vibrates with the gun, and an index at the extremity of a bar on that axis remains at rest till the gun has recoiled as far as the force of the fired gunpowder can impel it; when, by a simple contrivance, it is made to return with the quadrant, showing, by the degree in coincidence with it, the extent of the recoil.

In the eprouvette constructed by Dr. Hutton, the quadrant had on it three graduated arcs: one of these showed the degrees in the angle of recoil; another showed by inspection the length of the chord; and the third showed in like manner the length of the versed sine of the arc of recoil.

In using the instrument, the gun is charged with a given quantity of powder, which is introduced without a cartridge, and is fired, when exactly in a horizontal position, by means of a piece of quick match: the extent of the arc of recoil is then to be measured or read.

The velocity acquired by a body on describing half a vibration in a circular arc, varies (by mechanics) with the square root of the vertical height, or with the chord of the half vibration: hence, if by the explosions of equal charges of different kinds of powder in a suspended gun, the latter be made to recoil from a vertical position through arcs or angles which are measured in degrees, the velocity resulting from the force which produced the recoil being equal to that which the gun would have acquired in descending by gravity from the upper extremity to the lowest point of the arc; it follows that the chords of those arcs or angles will express the relative velocities produced by the different kinds of powder. Again, by mechanics, the forces are as the squares of the velocities; and these, when produced by a body descending on circular arcs, are as the versed sines of the arcs; therefore the angles of recoil, or the half vibrations, being found from the experiments, their versed sines will express the relative forces of the different kinds of powder.

A gun suspended in the manner above described has been employed, instead of the ballistic pendulum, to determine, by its recoil, the initial velocity of the shot fired from it with a given charge of powder. [BALLISTIC PENDULUM.]

The mortar eprouvette generally consists of an eight-inch Gomar mortar, fired with a very small charge (2 to 4 ozs.) and an accurately turned iron shot. The range required for 4 ozs. of powder is about 380 feet. This method is the one usually adopted for testing powder, and is employed for testing the powder made for government by contractors. Its comparative results for different powders, unless the powders are of the same size grain, are, however, wholly fallacious. A small charge of powder *fine grained* will give a much greater range than the same charge of the same powder *coarse grained*. When, however, the charges are large, the coarse-grained powder gives the greatest range; the interstices between the grains being large, allow the heated gas to find its way through and inflame the whole charge more rapidly, which is more than compensated for when the charge is small by the greater extent of surface exposed by the small grains. [Gunpowder.]

EPSOM SALT. [Magnesium, *Sulphate of.*]

EQUAL. Two magnitudes are equal when one of them may be made to coincide with the other. This is the geometrical definition of Euclid, and is placed by him among the axioms, though in reality it is nothing more than the definition of the word equal. Nor is it quite sufficient: a triangle, for instance, and a parallelogram, may be equal in area, and yet neither can, without alteration of form, be made to occupy the same space as the other. The truth is, that the idea of equality is one which will admit no definition; and moreover, it is to the more general notion of the existence of ratio (of which equality is one particular case) that all discussion upon this term should be referred. Nor is the notion of equality to be confined to magnitudes connected with space.

Some geometers have proposed to use the word equivalent as applied to surfaces of equal area but different forms; and the distinction is at least harmless. We cannot say more; for when it is once established that the term used by Euclid is to be understood in a wider sense than the words of the axiom will bear, no liability to confusion remains.

There is one little warning which beginners in mathematics often want. *Equal* is an adjective which, by its own meaning, has no singular number except in conjunction with *to.* Thus A and B may be *equal;* and A may be *equal to* 8; but there is no meaning in "A is equal," taken alone.

EQUALITY, APPROACH TO. As a general rule, that which may be stated as absolutely true when an equation is true, may be stated as nearly true when that equation is only nearly true. Usage of words however is apt to lead to mistake when it is equality, and nearness to equality, which are in question: A and B are absolutely equal when either of the following equations is true; one of them being of course a consequence of the other:

$$A - B = 0 \qquad \frac{A}{B} = 1$$

and it is usual to say that a *small* quantity is *nearly nothing* or *near to nothing.* In strictness, we might as well say that a large quantity is near to infinity, as that a small quantity is near to nothing: both infinity and nothing are limiting terms, except only as to the latter, when obtained by subtraction. [Infinite.] Nevertheless we can hardly hope to abolish the common idea of small quantities being next to nothing: we must therefore guard those who accept this phraseology from the mistake to which it very frequently leads.

It is not true that quantities are necessarily nearly equal when their difference is near to nothing (meaning small). If by small we here understand small with respect to the quantities themselves, it is true; but not otherwise. If $A-B$ be a small fraction of A, let it be m A, where m is a small fraction of unity; then $A-B=m\,A$ gives

$$\frac{B}{A} = 1 - m$$

or B and A are in the ratio of $1-m$ to 1, nearly that of 1 to 1. But if A and B be both small, their difference is small: and yet that difference may be itself many times greater than the smaller of the two quantities from which it was obtained. If the bulk of the sun be unity, the earth and moon are both small fractions; but not nearly equal. When therefore we want to think of approach to equality, we must rely on approach to

$$\frac{A}{B} = 1, \text{ not to } A - B = 0$$

We are here merely guarding a phrase, not explaining principles at length. In the articles Infinite; Limit; Fractions, Vanishing, will be found the elementary notions, proper attention to which will secure the beginner from error.

When a person, for any common purpose, speaks of a small quantity as next to nothing, he compares it with the whole mass from which it is taken, and he always means by small that which is a small fraction of any important quantity. The terms small and great being purely relative, may have many meanings in different circumstances; but with that we have here nothing to do. Whatever *small* may mean, we have no right to say that quantities of small difference are nearly equal, except only when the relative word small may be properly used in relation to the quantities themselves.

This last caution is the more necessary to the young mathematician, from his frequently meeting with the words small and great in an absolute sense. Though this absolute use of the words is only an abbreviation [Infinite,], he may, without care, now and then forget that it is so.

EQUATION (Astronomy). The characteristic of all the heavenly motions is, that they nearly follow a simple law, but not quite. The small corrections which must be added to or subtracted from the results of the simple law, in order to secure accurate prediction, are called equations. Thus, the moon moves round the earth with a motion which is not very far from uniform: the average motion is therefore ascertained, and, starting from a given epoch, at which the true place is known, the longitude for that epoch is first increased by the longitude which would have been described by the moon, had she moved with her average motion. The result must then be altered by a number of different *equations,* some being consequences of the elliptic figure of the moon's orbit, some of the sun's attraction, &c. When all these equations have been annexed, the result is the moon's longitude for the time proposed.

EQUATION (in pure mathematics), an assertion of the equality of two magnitudes, represented to the eye by the symbol =. Thus $A=B$ is to be understood as a proposition, declaration, or assertion that the magnitude A is equal to the magnitude B. It is not immaterial to insist upon this definition; for beginners frequently confound the notion of an equation (an *assertion* of equality) with the idea of equality itself, and speak of two *equations* being *equal,* and of one equation being greater than another.

To treat of equations is to write on mathematics in general; for when two magnitudes A and B are of the same kind, A must be either greater than, equal to, or less than B. The objects of mathematics generally require that it should be determined (supposing A and B not equal) by how much one exceeds the other: and the assertion that A exceeds B, and exceeds it by M, is equivalent to the *equation* $A=B+M$. The assertion of inequality is called by continental writers an *inequation:* and one work (we are not aware of any other) has been written on the subject; Canard's 'Traité des Inéquations,' &c.

An equation may be one of two kinds: necessarily true, whatever may be the value of the symbols employed, and called *identical;* or true only upon the supposition of some particular value being given to certain magnitudes, or of some particular relations existing. The latter species are called equations of *condition.* Thus—

$$a=a, \quad a+a=2a, \quad (a+b)^2=a^2+2ab+b^2$$

are identical equations: while

$$2a+1=13, \quad x^2=5x-4$$

are equations of condition; the first requiring that a should be 6, and the second that x should be either 4 or 1. Again, $a+b=1$ is an equation of condition.

Certain equations being supposed to be true, the determination of all their consequences, that is, of all equations which follow from them, is the great object of mathematical analysis. The difficulties which lie in the way are of various classes, and give rise to various modes of considering equations. These are so widely separated from each other, and diverge into such different subjects, that we can here do no more than point out two or three of the most remarkable species of inquiries. This we shall do in articles headed by the word Equation.

The theory of equations is a branch of algebra which is not correctly named; and which we refer to Theory of Equations. It is the theory of *rational and integral expressions,* which, having grown out of attempts to solve equations, and having the solution of equations among its most important requirements, has gained a name which does not express its full scope.

EQUATION ANNUAL. [Moon.]

EQUATION OF THE CENTRE. [Moon; Sun, &c.]

EQUATION OF THE EQUINOXES. [Precession.]

EQUATION OF TIME. [Sun.]

EQUATION, BINOMIAL. A binomial equation is an algebraical equation of two terms. Its form is therefore $ax^n + bx^m = 0$, all the consideration of which may easily be reduced to that of one or other of the forms $x^n \pm a^n = 0$ (n being integer). All that is necessary will be given in the article Root, and we shall here confine ourselves to such statement of the mode of resolving $x^n \pm a^n$ into factors as may be useful for reference.

First, as to $x^n - a^n$. Of this $x-a$ is always a factor, and if n be even, $x+a$ is also a factor. The remaining factors are all of the form

$$x^2-2\cos\theta.\ ax+a^2$$

in which θ may be either the quantity $\frac{2\pi}{n}$ or any multiple of it less than $\frac{1}{2}n$. Thus whether n be 10 or 9, we go as far as four times $2\pi \div n$, since 4 is the integer next less than the half either of 10 or 9. According, if $\frac{2\pi}{n}=\nu$, and if k be the integer next less than the half of n, we have

$$\begin{aligned} x^n - a^n &= (x-a) \\ &\times (x+a, \text{ if } n \text{ be even}) \\ &\times (x^2-2\cos\nu.\ ax+a^2) \\ &\times (x^2-2\cos 2\nu.\ ax+a^2) \\ &\times \;.\;\;.\;\;.\;\;.\;\;.\;\;.\;\;. \\ \text{up to } &\times (x^2-2\cos k\nu.\ ax+a^2). \end{aligned}$$

Next, as to $x^n + a^n$. Of this $x+a$ is a factor if n be odd: and the remaining factors are of the above form, θ being $\frac{\pi}{n}$ or any *odd* multiple of it which does not equal n. Thus whether n be 10 or 11, we go as far as 9 times $\pi \div n$, since 9 is the last odd integer which does not equal either 10 or 11. If then $\nu = \pi \div n$, and k be the last odd number which does not equal n, we have

$$\begin{aligned} x^n + a^n = & (x + a, \text{ if } n \text{ be odd}) \\ & \times (x^2 - 2a \cos \nu.\ ax + a^2) \\ & \times (x^2 - 2a \cos 3\nu.\ ax + a^2) \\ & \times (x^2 - 2a \cos 5\nu.\ ax + a^2) \\ & \times \ldots\ldots\ldots \\ \text{up to } & + (x^2 - 2a \cos k\nu.\ ax + a^2). \end{aligned}$$

Closely connected with the binomial equation is the trinomial equation—

$$x^{2n} \pm 2 \cos \lambda.\ a^n x^n + a^{2n} = 0$$

the left-hand side of which is thus reduced:—

For $x^{2n} - 2 \cos \lambda.\ a^n x^n + a^{2n}$ the factors are—

$$x^2 - 2 \cos \frac{\lambda}{n}.\ ax + a^2$$

$$x^2 - 2 \cos \frac{\lambda + 2\pi}{n}.\ ax + a^2$$

$$x^2 - 2 \cos \frac{\lambda + 4\pi}{n}.\ ax + a^2$$

and so on up to

$$x^2 - 2 \cos \frac{\lambda + \overline{2n - 2}\pi}{n}.\ ax + a^2$$

For $x^{2n} + 2 \cos \lambda.\ a^n x^n + a^{2n}$ the factors are—

$$x^2 - 2 \cos \frac{\lambda + \pi}{n}.\ ax + a^2$$

$$x^2 - 2 \cos \frac{\lambda + 3\pi}{n}.\ ax + a^2$$

$$x^2 - 2 \cos \frac{\lambda + 5\pi}{n}.\ ax + a^2$$

add so on up to

$$x^2 - 2 \cos \frac{\lambda + \overline{2n - 1}\pi}{n}.\ ax + a^2$$

(For the *algebraical* solution of binomial equations, see the works of Gauss or Legendre on the theory of numbers, or Murphy's *Theory of Equations* in the *Library of Useful Knowledge*.)

EQUATION OF PAYMENTS, an arithmetical rule, for the purpose of ascertaining at what time it is equitable that a person should make payment of a whole debt which is due in different parts payable at different times. This rule is now of no practical use, as it rarely, if ever, happens that it is considered necessary to *equate* payments. Sums of money due at future periods are generally secured by bills of exchange or by promissory notes, and when the date of payment is altered, it is usually immediate payment which is contemplated. [DISCOUNT.]

EQUATION, PERSONAL. It is a fact which has now been for some years established, and which might reasonably have been suspected, that different persons, attempting to observe the precise moment of a phenomenon, by means of a clock which beats seconds, do not agree exactly in their results, but differ generally in one and the same way, one of the observers being almost always a little before the other in the moment which he assigns to the phenomenon. If this had not been the case, if one of the observers had been about as often before the other as behind him, the difference could only have been considered a simple casualty. But, looking upon the constant occurrence of a difference of one kind between two observers, it becomes obvious that the cause is in the organs of the men themselves; and that physical constitution, temperament, habit, &c., make differences between one person and another.

Personal Equation is a name given to the quantity of time by which a person is in the habit of noting a phenomenon wrongly; and it may be called *positive* or *negative*, according as he notes it after or before it really takes place. Thus if A and B are severally in the habit of noting events 3-tenths of a second after and 4-tenths of a second before they take place, their personal equations may be described as being $+0^{s}\cdot3$ and $0^{s}\cdot4$.

The absolute personal equation of any one is a thing undiscoverable; since we can only refer one human observer to another, and note the difference of their times of observing the same phenomenon. If we could cause a thousand persons to note a given definite phenomenon by one clock, and if we could take the mean of all their results, we might say that there is very strong reason to presume that the mean is the time which perfect organs would have noted: for we may think that the chances are much in favour of human imperfection being, in the mass, as much of one kind as of the opposite. But a little consideration will show that this reasoning is not to be relied on. It may be that the whole race has, by its constitution, a rather large personal equation of one or the other kind: for we can only see the differences, without knowing upon what quantities they are differences. This question is, however, practically immaterial; for any given amount of personal equation common to the whole race is equivalent to making all the clocks wrong by the same quantity. Suppose, for example, that every person suddenly received an addition of one second to his personal equation, or began to note phenomena a second later. The astronomers would then begin to find the clocks a second too fast, in comparing observation with prediction; as soon as the clocks had been rectified every thing would be as before.

The first notice we have of personal equation is in an announcement by Maskelyne, in the volume of Greenwich Observations for 1795. He tells us that he was obliged to part with one of his assistants, because the latter, who had till then always agreed with him in his observations, suddenly began, in August, 1794, to observe half a second later: and that in January, 1796, the difference amounted to 8-tenths of a second. Maskelyne inferred that his assistant had contracted some bad habit of observation: it is now very well known that age causes persons to observe later than they did before, though it is not usual for the habit to undergo such sudden changes as in the above case. In 1823 Mr. Bessel, at Königsberg, ascertained that he was in the habit of observing phenomena as much as $1^{s}.22$ before his assistant Mr. Argelander. The latter left his post to take charge of the observatory at Bonn: but, passing through Königsberg in 1832, Mr. Bessel took the opportunity to make some further comparisons with him; and it was found that the above quantity was reduced to $1^{s}\cdot06$. Age had brought them nearer together. A close trial of the subject was made by MM. Quetelet and Sheepshanks, 1838-1841, in determining the longitude of Brussels by transmission of chronometers between that place and Greenwich. This method of course requires the most careful transit observations at both places, and the personal equation* becomes of considerable importance. It was necessary that some observer should compare himself with M. Quetelet at Brussels, and with the assistants at Greenwich. This was undertaken by Mr. Sheepshanks, and the result ascertained was, that he came, one observation with another, 45-hundredths of a second behind M. Quetelet, and 27, 35, and 24-hundredths before MM. Main, Henry, and Ellis, severally. The result was that the longitude of Brussels was found to be three-quarters of a second less than it would have been supposed to be if the difference of personal equations had been unknown. (See a memoir on the difference of the longitudes of Brussels and Greenwich, by MM. Quetelet and Sheepshanks, *Mém. de l'Acad. Roy. de Bruxelles*, vol. xvi.)

EQUATIONS, DIFFERENTIAL, and EQUATIONS of DIFFERENCES. The difficulty in this case is the inversion of the processes of the Differential Calculus and the Calculus of Differences. We give an example of each case:—$\frac{d^2y}{dx^2} - \frac{dy}{dx} = x$, is a differential equation. The question asked is, what is y, that function of x, of which it is the property that the first differential coefficient subtracted from the second will always leave x.

$\Delta y = y + 1$, is an equation of differences. The question asked is, what must y (understood to be a function of x) be, in order that an increase of a unit in the value of x shall increase y by $y + 1$. This is in reality a simple functional equation, as follows. Required ϕx so that

$$\phi(x+1) - \phi(x) = \phi x + 1.$$

The two classes of equations, thus briefly noticed, include in their history that of most of the mathematico-physical sciences. The progress of the theory of gravitation since Newton is contained in successive attempts to solve certain differential equations. All questions of dynamics, electricity, the theory of light and heat, &c. &c., resolve themselves at last into the solution of differential equations. Works on the differential calculus contain but little on this subject, its utility considered; and it is to the applications themselves that the student must look for further information.

We shall now give a slight synopsis of results, such as may be useful to the advanced student, as a guide to his reading, or for reference. We have not room either to teach the subject or to illustrate it by examples. We may refer to the following works:—Moigno, 'Leçons de Calcul Differentiel,' &c., vol. ii. Paris, 1844, 8vo.; De Morgan, 'Differential and Integral Calculus,' London, 1842, 8vo. (Lib. of Useful Knowledge); various numbers of the 'Cambridge Mathematical Journal,' Cambridge, 1839, &c. 8vo.; Brooke, 'Synopsis of the . . Formulæ . . of Pure Mathematics,' Cambridge, 1829, 8vo.; Peacock, Herschel, and Babbage, 'Collection of Examples,' &c., Cambridge, 1820, 8vo.; Gregory, 'Examples of the Differential Calculus,' Cambridge, 1841, 8vo.; Boole, on 'Differential Equations,' Cambridge, 1859. We must confine ourselves to a selection from striking points, or our article would exceed all reasonable limits.

1. Let there be a function $\phi(x, y, a, b, c \ldots)$, or ϕ, containing the variables x and y and the n constants, $a, b, c, \ldots$ If we make $\phi = 0$, we tacitly require that y should be a function of x. If between $\phi(x, y \ldots) = 0$, and the result of complete differentiation, $\phi'(x, y, \ldots) = 0$, we eliminate one of the constants, we get a new equation contain-

---

* It is usual to call the difference between two observers the *personal equation*; but this ought to be called the *difference of their personal equations*, or their *personal difference*. The personal equation of an observer is, properly speaking, the difference between him and the average of the human race.

ing x, y, y' (or $dy : dx$) and all the rest of the constants; and according as we eliminate one or another constant, we have one or another of as many such equations as there were constants. These are called differential equations of $\phi=0$, and they are said to be of the *first order.*

2. The word *order* refers to the number of differentiations, the word *degree* to the highest power of the highest differential coefficient which enters. Thus $y''^4+y'^5=x$ is a differential equation of the second order and the fourth degree. Let the accents always denote complete differentiation with respect to x. For partial differentiation we shall save room by writing as follows:—ϕ'_x for $\frac{d\phi}{dx}$, ϕ'_y for $\frac{d\phi}{dy}$, &c.

3. If we eliminate two of the constants between $\phi=0, \phi'=0, \phi''=0$, we have a differential equation of the second order, and so on; there are altogether $\frac{1}{2}n\,(n-1)$ differential equations of the second order, if we have n constants. And generally, when there are n constants, there are as many differential equations of the mth degree as there are ways of taking m out of n things. Thus there is only one equation of the nth degree.

4. If there be a system of p equations between $p+1$ variables, so that p of the variables are functions of the remaining one, and if we differentiate each equation once, we can eliminate p constants, and form p equations of the first order. With p second differentiations, we can eliminate p other constants, and so on. And if there were $p+q$ variables, we should have similar systems with q independent variables.

5. Equations of differences are formed in a corresponding way by taking differences instead of differential coefficients. Thus suppose u_x means u, a function of x, and $\phi\,(x, u_x, a)=0$. Change x into $x+\Delta x$, usually into $x+1$, and let u_x then become u_{x+1}, or $u_x+\Delta u_x$. If we eliminate a between $\phi\,(x, u_x, a)=0$ and $\phi\,(x+1, u_{x+1}, a)=0$, we have an equation of the form $\psi\,(x, u_x, u_{x+1})=0$, or $\psi(x, u_x, \Delta u_x)=0$, as we please, and this is an equation of differences of the first order. But exactly the same equation would be obtained, if for a we had substituted any function of $\cos\,(2\pi x)$, or of $\cos\,(2\pi x\div\Delta x)$. On this point see INVARIABLE.

6. When there are more than two variables, say three, it is possible to form an equation in which an arbitrary function of a definite function of two of them shall be eliminated. Thus, if $\phi\left\{x, y, z, \psi a\,(x, y)\right\}=0$, in which z is an implied function of x and y and $a\,(x, y)$ a given function; we differentiate with respect to x and y separately, and produce three equations involving $x, y, z, z'_x, z'_y, \psi a\,(x, y)$ and $\psi' a\,(x, y)$. From these three eliminate the two last, ψ and ψ', and we get an equation involving only x, y, z, z'_x, z'_y, in definite forms. This is called a partial differential equation.

7. The analogies between the constants of a common differential equation and the arbitrary functions of a partial one must not be relied on as capable of being carried all lengths. It is not, for instance, universally true that two arbitrary functions may be completely eliminated by differentiations of the second order.

We now consider common differential equations of the first order.

8. Let $y=\phi\,(x, c)$, and $y'=\phi'\,(x, c)$, and let elimination give $y'=\chi(x, y)$, the differential equation. There is another mode of arriving at the same result. Let $y=\phi\,(x, c)$ give $c=\Phi\,(x, y)$, or $0=\Phi'_x+\Phi'_y\,.\,y'$. The constant here disappears by mere differentiation, and $\chi\,(x, y)$ must be identical with $-\Phi'_x : \Phi'_y$.

9. The difficulty of returning to the primitive from the equation $y'=\chi\,(x, y)$ consists in that of reducing it to the form $\Phi'_x+\Phi'_y\,.\,y'=0$. Generally speaking, common factors are made to disappear, and the restoration of these factors is a problem of exactly the same difficulty as the solution of the equation.

10. The quantity $\mathrm{P}+\mathrm{Q}y'$, P and Q being functions of x and y, is integrable at once when $\mathrm{P}'_y=\mathrm{Q}'_x$. When this condition, which is usually called the criterion of integrability, is satisfied, the integral is

$$\int \mathrm{P}dx+\int\left(\mathrm{Q}-\frac{d}{dy}\int \mathrm{P}dx\right)dy$$

in which y is constant in the first integration, and x in the second. Any arbitrary constant may be added. Either of the following forms are also integrals of $\psi\,(x, y)+\chi\,(x, y)\,.\,y'$, if the criterion be satisfied.

$$\int_a^x \psi\,(x, y)\,dx+\int_b^y \chi\,(a, y)\,dy$$

$$\int_b^y \chi\,(x, y)\,dy+\int_a^x \psi\,(x, b)\,dx.$$

11. The equation $y'=\chi\,(x, y)$ can have no other primitive with an arbitrary constant, except $y=\phi\,(x, c)$ from which it was derived. But it may have another solution which has not an arbitrary constant, or even more than one: these are called singular solutions. A singular solution makes χ'_x and χ'_y infinite if y be substituted from it in terms of x. It also makes Φ'_x and Φ'_y infinite in the same manner. All the solutions of either or both $\Phi'_x=0$ and $\Phi'_y=0$ are singular solutions; and all the singular solutions are thus found. But though the most prominent and useful singular solutions are sure to be obtained from $\chi'_x=\infty$ and $\chi'_y=\infty$, these equations may not contain all singular solutions, nor do they give nothing but singular solutions. But any solution of $\chi'_y=\infty$ which makes $\chi'_x+\chi'_y\,\chi$ finite is a singular solution of the equation $y'=\chi$.

12. The singular solution may also be found from the primitive $y=\phi\,(x, c)$, as follows. Eliminate c between $y=\phi\,(x, c)$ and $0=\phi'_c\,(x, c)$, the result is the singular solution. This rule and the last are subject to exception, when the singular solution takes the form $x=$ constant or $y=$ constant.

13. The geometrical character of a singular solution is as follows. If $y=\phi\,(x, c)$ be the equation of a family of curves, that is, of one curve for each value of c, the differential equation $y'=\chi\,(x, y)$ also belongs to every member of that family. The singular solution is the equation of the curve which touches every one of the family of curves.

14. The equation $y=y'x+\phi\,(y')$ is historically remarkable as having led to the theory of singular solutions: it is called *Clairaut's form.* The complete primitive is $y=cx+\phi c$, belonging to a family of straight lines: the singular solution is found by eliminating c between this and $x+\phi' c=0$.

15. Singular solutions are either *intraneous,* contained in the general solution as particular cases; or *extraneous,* not so contained. These two species do not differ in geometrical character. A remarkable theorem of Cauchy discriminates between them, as follows:—

Let $y=\mathrm{P}$ be a solution of $y'=\chi(x, y)$, and let β be any small quantity. If, then, x being constant,

$$\int_{\mathrm{P}}^{\mathrm{P}+\beta}\frac{dy}{\chi(x, y)-\chi(x, \mathrm{P})}$$

be finite, $y=\mathrm{P}$ is an extraneous solution; if infinite, intraneous.

16. It is not often that the factor which makes an equation integrable can be recovered in any general form. As soon as the solution is obtained, it can always be found; but the only use of it is to find the solution. There is always an infinite number of such factors, any one of which will do. When in $\mathrm{P}+\mathrm{Q}y'$, the criterion $\mathrm{P}'_y-\mathrm{Q}'_x$ is not $=0$; yet if $\mathrm{Q}^{-1}(\mathrm{P}'_y-\mathrm{Q}'_x)$ be a function of x only, and not of y, and if $\int \mathrm{Q}^{-1}\,(\mathrm{P}'_y-\mathrm{Q}'_x)\,dx=\mathrm{V}$, then $\epsilon^{\mathrm{V}}\,(\mathrm{P}+\mathrm{Q}y')$ is integrable.

17. The equation $y'+\mathrm{P}y=\mathrm{Q}$, in which P and Q are functions of x only, is always integrable. The factor of integration is $\epsilon^{\int \mathrm{P}dx}$, and the complete integral is

$$y=\epsilon^{-\int \mathrm{P}dx}\int \mathrm{Q}\epsilon^{\int \mathrm{P}dx}\,dx+c\,.\,\epsilon^{-\int \mathrm{P}dx}.$$

The equation $y'=\mathrm{P}y+\mathrm{Q}y^2$ is reduced to the preceding form by making $y=z^{-1}$; and $y'=\mathrm{P}y+\mathrm{Q}y^n$ by making $z=y^{1-n}$.

18. When P and Q are homogeneous functions of x and y, that is, when they are both of the form $x^n\,\phi\,(y : x)$, with the same value of n, the integrating factor is $(\mathrm{P}x+\mathrm{Q}y)^{-1}$. But generally the following method is more convenient. Having

$$\phi\,(x : y)+\psi\,(x : y)\,.\,y'=0$$

assume $y : x=u$, from whence

$$\frac{dx}{x}=-\frac{\psi u du}{\phi u+u\psi u}$$

to which common integration can be applied. The equation is now reduced to one in which the variables are said to be separated.

19. It is hardly necessary to say that the variables can be immediately separated in $\mathrm{P}+\mathrm{Q}y'=0$, whenever P and Q are both of the form $\phi x\times\psi y$.

20. It often happens that, when direct processes would require the previous solution of an equation of indefinite form, indirect processes will succeed in reducing the question of solution to one of elimination. Thus $x=f\,(y')$ is solved when y' is eliminated between this and

$$y=y'\,fy'-\int fy'\,dy'+c,$$

and $y=fy'$ is solved when y' is eliminated between it and

$$x=x'\,f\left(\frac{1}{x'}\right)-\int f\left(\frac{1}{x'}\right)dx'+c$$

where x' means $1 : y'$.

21. The equation $y=x\,\phi y'+\psi y'$ can be reduced to elimination, thus: Let $y'=z$, then

$$\frac{dx}{dz}-\frac{\phi' z}{z-\phi z}\,x=\frac{\psi' z}{z-\phi z}$$

which is of the form integrated in § 17. Eliminate z between the result of this and $y=x\phi z+\psi z$.

22. The equation $y=\phi\,(x, y')$ can be reduced to a form of the first degree and elimination. Let $y'=z$, then $z=\mathrm{P}+\mathrm{Q}z'$, where P and Q are $\phi'_x\,(x, z)$ and $\phi'_z\,(x, z)$. If this equation can be integrated, we eliminate z between the result and $y=\phi\,(x, z)$. The form $x=\phi\,(y, y')$ may be treated in a similar manner. Or generally, let the equation be $\phi\,(x, y, y')=0$; that is, $\phi\,(x, y, z)=0$, which gives by differentiation a form $\mathrm{P}+\mathrm{Q}z+\mathrm{R}z'=0$. If from this we eliminate y, by substitution from the preceding, we have an equation of the first degree as to z'; from which, if integration be possible, elimination will determine the relation between x and y.

23. Any differential equation whatever may have a chance of reduc-

tion to an easier form in the following way: Let Y be a function of X, and let Y′ mean $d\text{Y} : d\text{X}$, &c. Take the following sets of quantities:—

x	y'
y	$xy'-y$
y'	x
$xy'-y$	y
y''	$1:y''$
$1:y''$	y &c.

In $\phi(x, y, y', y'', \&c.)=0$, write for each of x, y, y', &c., the quantity opposite to it in the list above. If the equation thus produced can be integrated into $\text{Y}=\psi\text{X}$, then by eliminating X from $x=\text{Y}'$, $y=\text{XY}'-\text{Y}$, the relation between x and y which satisfies $\phi(x, y, y', \&c.)=0$ is found.

24. Various substitutions will sometimes aid in the solution of an equation, as $y=ux$, $y=u^{-1}$, $=u^m$, $y=\epsilon^u$, and so on: sometimes, when a couple of expressions of the form $ax+by+c$, $a'x+b'y+c'$, occur, it will be convenient to introduce two new variables derived from equating the preceding to $\text{A}u+\text{B}w$ and $\text{A}'u+\text{B}'w$. We have given the most effective general methods; the number of transformations * which have succeeded in particular cases is very large.

25. When the equation is of the first order, but of a higher degree, as

$$\text{P}_n y'^n + \text{P}_{n-1} y'^{n-1} + \ldots + \text{P}_1 y' + \text{P}_0 = 0,$$

the theoretical mode of proceeding, occasionally convenient enough in practice, is to find the n values of y', say $y'=\phi_1(x, y)$, $y'=\phi_2(x, y)$, &c. If these can be separately integrated, giving, say $\psi_1(x, y, c)=0$, $\psi_2(x, y, c)=0$, &c., then the complete primitive of the equation is

$$\psi_1(x, y, c) \times \psi_2(x, y, c) \times \ldots\ldots = 0.$$

26. When, in the last, P_n, P_{n-1}, &c., are all homogeneous functions of x and y of the same degree, proceed as follows: Reduce the equation to the form

$$y'^n + \text{A}_1 y'^{n-1} + \ldots + \text{A}_n = 0.$$

in which A_1, &c., are of the form $\phi(y:x)$. Let $y=tx$ and find, in terms of t, the several values of y' or $t+xt'$, from the equation. Now $t+xt'=\phi t$, is an equation in which the variables can be separated. Solve each equation, and proceed as in the last.

27. The only equation of differences of the first order which can be generally treated, at present, is the form $\Delta u_x - \text{P}_x u_x = \text{Q}_x$, where P_x and Q_x are functions of x, or its corresponding form $u_{x+1} - \text{P}_x u_x = \text{Q}_x$. Supposing x to be an integer, which is what is usually required, let Σu_x denote $u_m + u_{m+1} + \ldots + u_{x-1}$, where m is an arbitrary integer chosen to start from. Accordingly $\Delta\Sigma u_x = u_x$. The solution of $u_{x+1} - \text{P}_x u_x = \text{Q}_x$ is

$$u_x = \text{P}_m \text{P}_{m+1} \ldots \text{P}_{x-1} \left\{ \text{C} + \Sigma \frac{\text{Q}_x}{\text{P}_m \ldots \text{P}_x} \right\}$$

28. Equations of differences in their most general form have solutions which appear to resemble the singular solutions of differential equations: but there are important points in which the resemblance fails. ('Differential Calculus—Library of Useful Knowledge,' p. 738.)

29. Let $y^{(n)}$ stand for the nth differential coefficient of y. The following expression

$$\text{P}_n y^{(n)} + \text{P}_{n-1} y^{(n-1)} + \ldots + \text{P}_0 y$$

is absolutely integrable, independently of all relation between y and x, if

$$\text{P}_0 - \text{P}_1' + \text{P}_2'' - \text{P}_3''' + \ldots = 0,$$

in which accents refer to complete differentiation with respect to x. And the integral is

$$\text{P}_n y^{(n-1)} + (\text{P}_{n-1} - \text{P}_n') y^{(n-2)}$$
$$+ (\text{P}_{n-2} - \text{P}'_{n-1} + \text{P}''_n) y^{(n-3)} + \ldots$$

One remarkable case is this:—each term $\text{P}_m y^{(m)}$ is absolutely integrable when P_m is a rational and integral function of x of a degree lower than the mth. Thus y^{iv}, xy^{iv}, x^2y^{iv}, x^3y^{iv}, are all integrable functions; and xy^{iv}, x^2y^{iv}, are also integrable.

30. The equation $y^{(n)}=\phi x$ is not only completely integrable, but it may easily have all its intermediate differential equations found. For instance, suppose $y^{\text{v}}=\phi x$. Multiply this successively by $1, x, x^2, x^3, x^4$, and, by the last section, we have five integrable equations, leading to the five differential equations of the fourth order which belong to $y^{\text{v}}=\phi x$. Treat the first result in the same manner with $1, x, x^2, x^3$, the second with $1, x, x^2$, the third with $1, x$, and the fourth with 1, and we have the 10 equations of the third order. Proceed in the same way with the results, taking care never to let any multiplication enter which raises the coefficient as high as the order of differentiation which it accompanies, and then will appear successively 10 equations of the second order, 5 of the first, and finally the original primitive.

31. The following theorems will sometimes be of use. Let P_n stand for $\int x^n \phi x dx$. Then the nth integral of ϕx, or $\left(\int dx\right)^n \phi x$, is the following series divided by $1.2.3\ldots(n-1)$

$$x^{n-1}\text{P}_0 - (n-1)x^{n-2}\text{P}_1 + (n-1)\frac{n-2}{2}x^{n-2}\text{P}_2 - \ldots$$

$$\text{and } (m+1)\int x^m \text{P}_n dx = x^{m+1}\text{P}_n - \text{P}_{m+n+1}$$

If the integrations in the last section be made by this last rule as they arise, the results will be given in terms of P_0, P_1, &c., and there will be no difficulty about the constants, which in the ordinary mode may appear to enter in too great numbers.

32. There are very few cases of equations of higher orders than the first which can be integrated in general terms. The equation $y''=\phi y$ gives

$$y'^2 = c + 2\int \phi y dy$$

which is integrable. Again, $y''+\text{Q}y'^2=\text{R}$, Q and R being functions of y, gives

$$x = \int \frac{\text{W}dy}{\sqrt{(2\int \text{RW}^2 dy)}} \text{ where log. } \text{W} = \int \text{Q}dy$$

and, by a change of the independent variable, $y''+\text{P}y'+\text{Q}y'^3=0$ gives, if P and Q be functions of x,

$$y = \int \frac{\text{W}dx}{\sqrt{(2\int \text{QW}^2 dx)}} \text{ where log. } \text{W} = -\int \text{P}dx.$$

33. The term *linear* equation is generally applied to one of the form

$$y^{(n)} + \text{P}_1 y^{(n-1)} + \ldots + \text{P}_n y = 0$$

in which P_1 &c. are functions of x only. If a solution be found which has not n distinct arbitrary constants, it is not the most complete solution, but is called a *particular* * solution. It is a most important property of the linear equation that if n distinct particular solutions can be found, say $y=\text{Y}_1$, $y=\text{Y}_2$, &c., then the complete solution is

$$y = \text{C}_1\text{Y}_1 + \text{C}_2\text{Y}_2 + \ldots + \text{C}_n\text{Y}_n$$

where C_1, C_2, &c., are any arbitrary constants.

34. The most remarkable case is that in which the coefficients are constants, as in $y^{(n)} + a_1 y^{(n-1)} + \ldots + a_n y = 0$. If the equation $k^n + a_1 k^{n-1} + \ldots + a_n = 0$ have n unequal roots, α, β, γ, &c., the general solution is

$$y = \text{A}\epsilon^{\alpha x} + \text{B}\epsilon^{\beta x} + \text{C}\epsilon^{\gamma x} \ldots\ldots$$

but if there should be, say m roots equal to α, the term which must belong to α in the solution is of the form

$$(\text{A}_0 + \text{A}_1 x + \ldots + \text{A}_{m-1} x^{m-1})\, \epsilon^{\alpha x}$$

A pair of imaginary roots, $\mu \pm \nu\sqrt{-1}$, contributes to the solution the term

$$\epsilon^{\mu x}(\text{K} \cos \nu x + \text{L} \sin \nu x)$$

Letters introduced without specific mention mean arbitrary constants.

35. The most remarkable particular case of the preceding is

$$y'' + a^2 y = 0 \qquad y = \text{K} \cos ax + \text{L} \sin ax$$
$$= \text{B} \cos (ax + \text{A})$$

No one differential equation is of so much importance as this.

36. When the equation is linear in all but an independent term, as

$$y^{(n)} + \text{P}_1 y^{(n-1)} + \ldots + \text{P}_n y = \text{X}$$

X being a function of x, its solution can be deduced from that of the linear form, in which $\text{X}=0$, by a method the importance of which will justify some account of it in a separate article. [VARIATION of PARAMETERS.] We give the following result of it: $y'' + a^2 y = \text{X}$ gives

$$a\, y = \sin ax \int \text{X} \cos ax dx - \cos ax \int \text{X} \sin ax dx$$
$$+ \text{K} \cos ax + \text{L} \sin ax.$$

37. The completed linear form (take the second order for an instance) $\text{P}_0 y'' + \text{P}_1 y' + \text{P}_2 y = \text{X}$ can be integrated (§ 29) one step if both sides be multiplied by the factor M, which satisfies the purely linear equation

$$\text{MP}_2 - (\text{MP}_1)' + (\text{MP}_0)'' = 0$$

This is another differential equation of the same order, but the difficulty is much reduced by it. The general solution of the last is not wanted; any particular solution will do. That is, if a particular solution of every linear equation could be found, the general solution of every completed linear equation could be deduced. And it will generally happen that when one particular solution can be found, to make an integrating factor, enough of them can be found to give the complete solution of the original equation.

38. The form $\phi(y, y', y'')=0$, in which x is wanting, may be reduced to an equation of the first order, by making $y'=z$, when it becomes

---

* The student must not be discouraged by finding that he does not succeed in solving cases which require detached artifices in the same manner as the writer of the elementary work before him. The art of solving equations is made evident: the art of constructing equations which can be solved is behind the curtain. There are few or no mathematical works, with many examples, to the writers of which the proverb may not be applied, that "those who hide know where to find."

* The word particular is here opposed to general. Note this, because some writers have used *particular solution* to signify what is now generally called *singular solution.*

$\phi\,(y, z, zdz : dy)$. If z or y' be thence found in terms of y, the variables can be immediately separated: if y be found in terms of z, we eliminate z between $y=\psi z$ as found and $x=\int(\psi' zdz : z)$.

39. As an *à priori* mode of constructing linear equations and their solutions, note the following: If $\phi\,(x, y, y', \ldots . y^{(n)})$ have for its solution $y=\psi\,(x, a, b, c, \ldots)$, a, b, c, &c., being arbitrary constants, and if P_0, P_1, P_2, &c., be the differential coefficients of ϕ with respect to y, y', y'', &c., considered as independent variables (with ψ substituted in them instead of y: then the solution of the linear equation

$$P_0 u+P_1 u'+P_2 u''+\ldots . P_n u^{(n)}=0$$

is

$$u=A\psi_a'+B\psi_b'+C\psi_c'+\ldots . .$$

A, B, &c., being new arbitrary constants.

40. If to an equation of the nth order, all the n equations of the $(n-1)$th order can be found, each with an arbitrary constant, there is no occasion for any further integration. For if $y', y'', \ldots . y^{(n-1)}$ be eliminated between the n equations, the result will be the complete primitive.

41. The purely linear equation, or indeed any one which is homogeneous with respect to y, y', y'', &c., can be lowered one order by assuming log. $y=\int zdx$, or $y=\epsilon^{\int zdx}$ (we have used the former, as more convenient to print). If this be done with $P_0 y''+P_1 y'+P_2 y=0$, it gives

$$P_0 z'+P_0 z^2+P_1 z+P_2=0.$$

42. In this way the solution of $y''=\phi x \,.\, y$ is connected with that of $z'+z^2=\phi x$. When $\phi x=ax^m$, it is called Riccati's equation, and it can be integrated in finite algebraical terms whenever $m=-4k : (2k\pm 1)$, k being a positive integer.

43. If only a particular solution of $y''+Py'+Qy=0$ can be found, then the general solution of $y''+Py'+Qy+R=0$ can be found from it. Let $y=Y$ be the particular solution of the first, and let log. $W=\int Pdx$: the general solution of the second is

$$y=-Y\int\frac{\int RYWdx}{Y^2W}\,dx.$$

44. If $\phi\,(x, y, y', y'')=0$ would become homogeneous with respect to x and y, by considering y, y' and y'' as of the dimensions $n, n-1, n-2$, assume $y=x^n u$, $y'=x^{n-1}v$, $y''=x^{n-2}w$, which reduces the equation to the form $\psi\,(u, v, w)=0$. Then deduce

$$(w-\overline{n-1}\,v)\,du=(v-nu)\,dv.$$

and substitute for w its value in terms of u and v. If this equation of the first order can then be integrated, giving, say $\chi\,(u, v)=0$, we have to complete the process by integrating $\chi(yx^{-n}, y'x^{-(n-1)})=0$.

45. To destroy the second term of $y''+Py'+Qy+R=0$ proceed as follows. Let $\xi=\int\epsilon^{-\int Pdx}dx$, and find x in terms of ξ. Then we have

$$\frac{d^2y}{d\xi^2}+(Qy+R)\,\frac{dx^2}{d\xi^2}=0$$

46. Any number of simultaneous equations which leave only one independent variable can be reduced to equations between two variables. For instance, let there be three equations between x, y, z, t, and differential coefficients of x, y, z, with respect to t. Now, looking upon x, x', &c. y, y', &c. (excluding z, z', &c.), as so many independent quantities, differentiate the three equations with respect to t. There are then introduced *two* new differential coefficients of x and y, and *three* new equations: or the number of equations gains one upon the number of quantities. Repeat the process, and the same thing happens again, and so on. Consequently a step must arrive at which the number of equations is made one more than the number of quantities. All the quantities can then be eliminated, and there results one equation between z, z' &c., and t. The same thing may be done with x and y. The process will also reduce the number of equations to as many as there are independent variables, whatever that number may be. The order of the result is the sum of the orders of the original equations.

47. In the simple case of $Ay'+Bz'+C=0$, $Py'+Qz'+R=0$, when A, P, &c., are functions of x, y, z, and z' is $dz : dx$, &c., we may proceed by eliminating y' and forming say $z'=M$, a function of x, y, z. Hence $z''=M'_x+M'_y\,y'+M'_z\,z'$, from which we may eliminate y and y' by the original equations, and thus produce an equation of the second order to determine z in terms of x. And the same for y in terms of x.

48. Let t be the independent variable, and let

$$x'=A_1x+B_1y+C_1 \qquad , y'=A_2x+B_2y+C_2$$

functions of t only. Determine θ and z from

$$\theta'=A_2\theta^2+(A_1-B_2)\,\theta-B_1$$
$$z'=(A_1+A_2\theta)\,z+C_1+C_2\theta$$

θ will generally be a function of double value; let θ_1 and θ_2 be its two values, and z_1 and z_2 the corresponding two values of z. Finally, determine x and y from

$$x+\theta_1 y=z_1$$
$$x+\theta_2 y=z_2.$$

49. When the forms are

$$x''=A_1x+B_1y+C_1 \quad , \quad y''=A_2x+B_2y+C_2$$

A_1 &c. being constants (a case which is often useful) determine the two values of θ from

$$B_1+B_2\theta=(A_1+A_2\theta)\,\theta$$

and the two values of z from

$$z''=(A_1+A_2\theta)\,z+C_1+C_2\theta$$

and find x and y from $x+\theta_1 y=z_1 \quad , \quad x+\theta_2 y=z_2$.

50. Also, when the simultaneous equations are linear, with constant coefficients, proceed as follows. Say there are four variables, x, y, z, t; and three equations. Assume $x=\epsilon^{at}$, $y=b\epsilon^{at}$, $z=c\epsilon^{at}$, and substitute: the result will be, after division by ϵ^{at}, three equations of the form $\phi\,(a, b, c)=0$, in which b and c only enter in the first degree. Hence the values of a can be found by an equation whose degree is the sum of the orders of the original equations, with one value of b and c for each value of a. Let the values be $a_1, a_2, b_1, b_2, c_1, c_2$, &c., then the complete solution is

$$x=C_1\epsilon^{a_1t}+C_2\epsilon^{a_2t}+\ldots .$$
$$y=C_1b_1\epsilon^{a_1t}+C_2b_2\epsilon^{a_2t}+\ldots .$$
$$z=C_1c_1\epsilon^{a_1t}+C_2c_2\epsilon^{a_2t}+\ldots .$$

C, &c. being arbitrary constants.

51. Whenever the solution of a differential equation depends upon that of an ordinary equation, and supposing the roots to be all different, the form of the solution is

$$x=C_1\,\phi\,(a_1t)+C_2\,\phi\,(a_2t)+\ldots .$$

the solution, though still a solution, ceases to be the complete solution when there are any sets of equal roots. If there be m roots equal to a, and if $\phi'\,x, \phi''\,x$, &c., be the successive differential coefficients of ϕx, this set of roots contributes to the value of x the terms

$$K\,\phi\,(at)+K_1\,\phi'\,(at)\,.\,t+\ldots\ldots+K_{m-1}\,\phi^{(m-1)}\,(at)\,.\,t^{m-1}$$

of which a particular case has been seen in § 34.

52. We now look at one equation with three variables, two of which are therefore independent. Let $Xdx+Ydy+Zdz=0$ be the equation. This may have arisen direct from $\phi\,(x, y, z)=c$, without alteration or loss of factors, &c.: and this will be the case when $X'_y=Y'_x$, $Y'_z=Z'_y$, $Z'_x=X'_z$, and then only. To return to the primitive, integrate $Xdx+Ydy$ (§ 10) as if z were constant, and let the result be P. The integral of $Xdx+Ydy+Zdz$ is then

$$P+\int(Z-P'_z)\,dz$$

Or thus: when the criteria are satisfied, the integral (omitting the usual commas, to save room) of

$$\phi\,(xyz)\,dx+\chi\,(xyz)\,dy+\psi\,(xyz)\,dz \quad \text{is}$$
$$\int_a^x\phi\,(xyz)\,dx+\int_b^y\chi\,(ayz)\,dy+\int_c^z\phi\,(abz)\,dz$$

in the first of which y and z are treated as constants, and z in the second.

53. If the criteria be not satisfied, a factor M may possibly exist, such that $MX\,dx+MY\,dy+MZ\,dz$ shall be integrable. But this cannot happen unless the following criterion be satisfied;

$$Z\,(X'_y-Y'_x)+X\,(Y'_z-Z'_y)+Y\,(Z'_x-X'_z)=0$$

and the factor, when this is satisfied, must satisfy any two of the three equations.

$$M\,(X'_y-Y'_x)+XM'_y-YM'_x=0$$
$$M\,(Y'_z-Z'_y)+YM'_z-ZM'_y=0$$
$$M\,(Z'_x-X'_z)+ZM'_x-XM'_z=0$$

But if the criterion be not satisfied, then there is no equation whatsoever between x, y, z, which always produces $Xdx+Ydy+Zdz=0$.

54. The equation $Xdx+Ydy+Zdz=0$, when produced from $\phi\,(x, y, z)=c$, is the equation of a family of surfaces, the individuals of which are defined by the different values of c. That is to say, any point of one of these surfaces being taken, and any other point infinitely near to it, the equation is satisfied by x, dx, &c., as derived from these points. But when the criterion is not satisfied, then $Xdx+Ydy+Zdz$ still belongs to any surface in the following limited sense. On any surface, and through any point of it, a curve may be drawn such that the equation $Xdx+$ &c. is satisfied if the two contiguous points first named be taken *on that curve.*

55. When there are three variables and two equations, with two constants, as in $\phi\,(x, y, z, a, b)=0$, $\psi\,(x, y, z, a, b)=0$; the most ready theoretical mode of imagining the differential equations formed is the reduction to the form $a=\Phi\,(x, y, z)$, $b=\Psi\,(x, y, z)$, and differentiation. Two equations of the form $Pdx+Qdy+Rdz=0$ are thus produced; from which, by combination, may be derived an infinite number of pairs of the same kind, answering to the infinite variety of pairs which can be produced from the primitive equations. This corresponds with the obvious geometrical fact that one curve may be the intersection of an infinite number of different pairs of surfaces.

56. A partial differential equation, such as $\phi\,(x, y, z, z'_x, z'_y)=0$, belongs to an infinite number of surfaces distinguished by the forms of the arbitrary function which enters into the solution. The most general method of proceeding is as follows, which supposes that a particular solution is found having at least *two* new arbitrary constants. Let $f\,(x, y, z, a, b)=0$ be such a solution, and call it a *primary* solution. Make $b=\mathrm{F}a$, where $\mathrm{F}a$ is any function of a, at pleasure. Then the *general* solution is

$$f\,(x, y, z, a, \mathrm{F}a)=0,$$

in which a is a function of x, y, z, determined from

$$f'_a\,(x, y, z, a, \mathrm{F}a) = 0.$$

The arbitrary character of $\mathrm{F}a$ introduces an arbitrary function.

The geometrical meaning of this is as follows: The primary solution, a and b being independent, is the equation of an infinite number of families of surfaces: when b is made $=\mathrm{F}a$, the equation is restricted to one of these families; and each case of the general solution answering to one form of $\mathrm{F}a$, is the equation of the surface which touches every individual of the family throughout the extent of some curve. Every surface which comes under the general solution is then tangent to a whole family of primary solutions. But it must not be forgotten that every primary solution is also a case of the general solution, so that there is no primary solution but what is also tangent to a whole family of other primary solutions.

57. There is generally a surface which touches all the surfaces of the general solution, and is a singular solution of the partial differential equation, not contained in the general solution. It is found by substituting in $f\,(x, y, z, a, b)=0$, values of a and b derived from

$$f'_a\,(x, y, z, a, b) = 0, \qquad f'_b\,(x, y, z, a, b) = 0.$$

We shall illustrate this subject in Variation of Parameters.

Let $\mathrm{X}u'_x + \mathrm{Y}u'_y = \mathrm{U}$, where X, &c. may be functions of x, y, and u. The integration entirely depends upon that of the following system of ordinary differential equations:—

$$\frac{dx}{\mathrm{X}}=\frac{dy}{\mathrm{Y}}=\frac{du}{\mathrm{U}}$$

if these can be integrated, and the results reduced to the form $a=\alpha\,(x, y, u)$, $b=\beta\;(x, y, u)$, α and β being functional symbols, then the complete integral of the given equation is $\beta=f\alpha$, or

$$\mathrm{F}\left\{\alpha\,(x, y, u), \beta\,(x, y, u)\right\}=0$$

f and F being any functions whatever.

This may be extended to any number of variables. Thus if

$$\mathrm{X}u'_x + \mathrm{Y}u'_y + \mathrm{T}u'_t = \mathrm{U},$$

let the solution of

$$\frac{dx}{\mathrm{X}}=\frac{dy}{\mathrm{Y}}=\frac{dt}{\mathrm{T}}=\frac{du}{\mathrm{U}}$$

be obtained in the form $a=\mathrm{P}$, $b=\mathrm{Q}$, $c=\mathrm{R}$, where a, b, c, are the constants introduced by integration, and P, Q, R, are functions of x, y, t, independent of those new constants. The complete solution of the partial differential equation is $\mathrm{F}(\mathrm{P}, \mathrm{Q}, \mathrm{R})=0$, F being any function whatever.

59. The same mode holds when there are several equations with two more variables than equations, if the multipliers of differential coefficients be the same in all. Thus the system $\mathrm{X}u'_x + \mathrm{Y}u'_y = \mathrm{U}$, $\mathrm{X}v'_x + \mathrm{Y}v'_y = \mathrm{V}$, $\mathrm{X}w'_x + \mathrm{Y}w'_y = \mathrm{W}$, can be integrated if the system

$$\frac{dx}{\mathrm{X}}=\frac{dy}{\mathrm{Y}}=\frac{du}{\mathrm{U}}=\frac{dv}{\mathrm{V}}=\frac{dw}{\mathrm{W}}$$

can be integrated in the form $a=\mathrm{P}$, $b=\mathrm{Q}$, $c=\mathrm{R}$, $e=\mathrm{S}$, described as before. The complete solution is the system

$\mathrm{F}_1(\mathrm{P}, \mathrm{Q}, \mathrm{R}, \mathrm{S})=0$, $\mathrm{F}_2(\mathrm{P}, \mathrm{Q}, \mathrm{R}, \mathrm{S})=0$, $\mathrm{F}_3(\mathrm{P}, \mathrm{Q}, \mathrm{R}, \mathrm{S})=0$, where F_1, &c., are symbols of any functions whatever.

60. Nearly all that can be done in this part of the subject depends upon cases of three variables and their connection with surfaces. The following notation is in universal use: Having z, a function of x and y, let z'_x and z'_y be denoted by p and q, and the second differential co-efficients z''_{xx}, z''_{xy}, z''_{yy}, by r, s, and t.

61. Let $z=px+qy+f\,(p, q)$ be the equation. A primary solution is $z=ax+by+f(a, b)$. The general solution, deduced as in § 56, gives the equation of all developable surfaces, if f be arbitrary. The form $q=\phi p$, ϕ being a given function, has $z=ax+\phi a.y+b$ for a primary solution, and belongs to a particular class of developable surfaces. Both these equations, and all developable surfaces, satisfy the equation $rt-s^2=0$.

62. For the method of dealing generally with the equation of the second degree, $\mathrm{R}r+\mathrm{S}s+\mathrm{T}t=\mathrm{V}$, see 'Differential Calculus,' in 'Library of Useful Knowledge,' p. 719. It would hardly yield a short account for a work of reference.

63. Let $r=a^2t$. Of this very important equation the complete solution is

$$z=\phi(y+ax)+\psi(y-ax).$$

ϕ and ψ being any functions.

64. Let $z=\phi\,(p, q)$. Solve the common differential equation $y=\phi\,(ay', y')$, giving, say $y=\psi\,(x, b)$. Then $z=\psi\;(y+ax, b)$ is a primary solution of the given equation.

65. Let $\phi(p, x)=\psi(q, y)$. Let $\phi(p, x)=a$, $\psi(q, x)=a$, give $p=\Phi\,(x, a)$ $q=\Psi\,(x, a)$. Then eliminate a from

$$z=\int\left\{\Phi(x, a)\,.\,dx+\Psi(y, a)\,.\,dy\right\}+\chi a$$

$$0=\frac{d}{da}\int\left\{\Phi(x, a)\,.\,dx+\Psi(y, a)\,.\,dy\right\}+\chi' a$$

χa being any function whatever of a.

66. Let X, Y, Z, be three new variables, and let P, Q, R, S, T be the differential coefficients of Z: that is $\mathrm{Z}'_x=\mathrm{P}$, $\mathrm{Z}'_y=\mathrm{Q}$, $\mathrm{Z}'_{xx}=\mathrm{R}$, &c. For the equation $\phi\,(x, y, z, p, q, r, s, t)=0$, substitute as follows:—

For x	P
y	Q
z	$\mathrm{PX}+\mathrm{QY}-\mathrm{Z}$
p	X
q	Y
$px+qy-z$	Z
r	$\dfrac{\mathrm{T}}{\mathrm{RT}-\mathrm{S}^2}$
s	$\dfrac{-\mathrm{S}}{\mathrm{RT}-\mathrm{S}^2}$
t	$\dfrac{\mathrm{R}}{\mathrm{RT}-\mathrm{S}^2}$

If the resulting equation can be integrated into $\mathrm{Z}=\psi(\mathrm{X}, \mathrm{Y})$, then the original equation is integrated by eliminating X and Y from

$$x=\mathrm{P} \quad y=\mathrm{Q} \quad z=\mathrm{PX}+\mathrm{QY}-\mathrm{Z}$$

67. Linear equations of differences with constant coefficients, such as

$$u_{x+3}+au_{x+2}+bu_{x+1}+cu_x=0$$

may be solved in a manner corresponding to linear differential equations by assuming $u_x=m^x$ and obtaining its particular solutions by means of $m^3+am^2+bm+c=0$.

We have not touched on the application of the calculus of operations, nor on that of definite integrals, subjects which are now of very great importance. On these points see Operation, Integrals, Definite. See also Function, Arbitrary.

It must be noticed that a great portion of the most important part of the subject of differential equations cannot enter in any work on pure mathematics. The physical subjects of gravitation, heat, electricity, &c., depend so much on certain differential equations that, by common consent, the details are referred to works on these subjects, and do not appear separately.

EQUATIONS, FUNCTIONAL. In this case the question is to find the form of a function which will satisfy certain conditions. For instance $\phi\,(x^2)=\phi\,x+1$. Here the question asked is, what is that algebraical expression which will be increased by 1, *whatever may be the value of* x, by changing x into x^2. [Functions, Calculus of.]

EQUATOR and ECLIPTIC, the two principal circles of the sphere. The first is that circle of the apparent celestial sphere which is in all points equally distant from both poles; the second, the circle through which the sun appears to move. The equator is so called from being the circle on the arrival of the sun at which the day and night become equal. The ecliptic derives its name from being the circle on which (or near which) the moon must be in the case of an eclipse. [Sphere, Doctrine of the.]

EQUATOR, MAGNETIC. [Magnetism.]

EQUATORIAL INSTRUMENT. This name is generally given to astronomical instruments which have their principal axis of rotation in the direction of the poles of the heavens. When the purpose of a machine of this nature is simply to carry a telescope, it has been called a *machine parallactique* or *parallatique* by the French, and sometimes *polar axis* by English writers; but we shall include both in this article.

The complicated system of circles which formed the *astrolabe* of Hipparchus, described by Ptolemy ('Almagest.,' lib. v. cap. i.), was made moveable on two pins, which marked the places of the pole in a metallic meridian circle, and thus may be called in some sort an equatorial. There is an excellent plate of the astrolabe in the title-page of Halma's translation, tom. i. This instrument and the copies which were made of it afterwards, according to Ptolemy's description, by the Arabs and by Walther of Nuremberg, were designed for observing the longitude and latitude of a heavenly body directly. The *torquetum* of Regiomontanus was for the same purpose, but surfaces were used instead of axes to determine motions, but we know not whether it was ever actually made. Tycho seems first to have seen the immense superiority of the simpler instrument, which sufficed for determining right ascension and declination: and the genuine equatorial is therefore due to him. In his 'Astronomicæ Instauratæ Mechanica,' Noribergæ, 1602, we find the figures and descriptions of three 'equatorial armillæ' of different sizes and constructions; in one, the diameter of the meridian circle was 7 cubits, or 10½ feet. (For Tycho's equatorials see Astrolabe.) In the 'Rosa Ursina' of Scheiner, Bracciani, 1626–30, p. 350 et seq., there is a plate and description of an equatorial mounting, invented by Gruenberger, to be used with a lens or telescope, for forming an image of the sun—the mode of observation then in vogue—or, with a telescope, in the modern manner for viewing the moon, stars, and other phenomena. Gruenberger's equatorial is almost identical with that described and figured by Cassini as his *machine parallactique*, 'Mémoires de l'Académie,' 1721, p. 18, and which is also drawn and described under the same name by Bailly, 'Histoire de l'Astronomie Moderne,' vol. i. p. 601, plate v., fig. 88; and by Lalande, 'Astronomie,' 1792, § 2400, et seq., plate xxiv. In 1674 Hooke published his 'Animadversions' on the first part of the 'Machina Cœlestis' of Hevelius. In this remarkable tract he describes, p. 67 et seq., tab. 2, fig. 15, the polar axis, on which he proposes to fix his quadrant for measuring intermutual distances, and "the watch-work, which is to make it move round in the same time with the diurnal revolution of the earth." * The regulator of the watch-work is a ball and string, describing a conical surface. When so near an approach had been made to this great desideratum in telescope-mounting, it is somewhat remarkable that nearly 150 years should have elapsed before it was realised. The astronomical sector with which Flamsteed observed at Greenwich from 1676 to 1689 bears so strong a resemblance to the quadrant and stand described in Hooke's tract, that we are inclined to attribute the merit of its contrivance to Hooke, particularly as he recommends the artificer Tompion as "having been imployed by him to make that which he had." Flamsteed's instrument was a sextant mounted upon a polar axis; and a description of the instrument, with a plate, will be found in the 'Historia Cœlestis,' vol. iii., p. 103.

The next step in the construction of the equatorial was made by Römer, to whom we owe the transit and circle, and whose merits as an astronomical mechanic surpass even his great countryman Tycho. According to Horrebow, 'Basis Astronomiæ,' p. 39, tab. 1, the equatorial of Römer was erected about 1690. Here we have the second essential to the instrument, a telescope mounted on a cross axis, which is placed at right angles to the polar axis; (this is sometimes called the *declination axis*, from its carrying the declination circle, or *transit axis*, from its analogy to the transit). In this construction the telescope can be pointed in every direction, and we have heard Römer's general idea recommended by a very competent judge as that which he would now follow in mounting a 20-foot telescope. Graham's differential sector and Sisson's equatorial are described in Vince's 'Practical Astronomy,' § 136 and 140, with figures; but the author has committed an error in his description. Graham's astronomical sector is supported like Hook's quadrant and Flamsteed's sextant (see Smith's 'Optics' § 885, book 3, chap. 9); but, in explaining the instrument, Smith uses a figure for illustration which Vince has copied as the actual instrument. It is in the Royal Observatory.

A portable equatorial stand for carrying a reflecting telescope was invented by Short, and is described and figured in the 'Phil. Trans.' for 1749. This must have been a very ricketty affair, judging from the plate. In 1771 Nairne gave a description and figure of a much better instrument in the same work; and in 1772, or 1773, P. and J. Dollond published an account of a "universal equatorial instrument, or portable observatory," which in firmness and contrivance is very similar to that of Nairne. This construction, with some slight variations, was followed by Ramsden, in a portable equatorial made for Sir George Schuckburgh, in 1779. All these portable equatorials labour under this serious defect; the telescope cannot be pointed on the same star in reversed positions, nor upon any star within 30° or 40° of the pole. Lalande, in his 'Astronomie,' § 2413, pl. xxvi., gives an account of an equatorial made by Megnié, for the President de Saron, in which this difficulty is overcome by fixing the telescope at the extremity of the cross axis, so as to overhang the hour circle. A very beautiful universal equatorial, in which the same position of the telescope is adopted, was constructed by Troughton, a figure and description of which will be given at the latter end of this article. There are some equatorials by Nairne and Adams which have a telescope at one end of the cross axis, but we are not aware that they have been figured or described.

A new era in the equatorial commences with the construction by Ramsden for Sir George Shuckburgh in 1791, which is elaborately described with plates in the 'Phil. Trans.' for 1793. In this instrument the telescope and the declination circle form a complete and symmetrical transit circle, which is supported at its extremities by two assemblages each of three long parallel brass tubes forming the polar axis. The upper ends of these tubes are set into a circular open frame, from the centre of which the top pivot rises, and their lower ends rest on the base of an inverted cone, which has the bottom pivot at its vertex. The polar axis is so long as to allow the telescope to revolve completely, and the object-glass is large enough to give a sight of the pole through the upper circle. The general form of this instrument is followed, with some variations, in almost every considerable English instrument which has been since made with the view of being used to measure with the circles. All have had a long polar axis supported at the extremities, and divided in the direction of its length into two limbs or cheeks, within which the declination axis is supported as a transit between its piers. Of this kind are the equatorials of Cambridge and Brussels, as well as of Armagh, described in Rees's 'Cyclopædia,' and of Camden Hill, described by Troughton, and figured in the 'Phil. Trans.' for 1825, in the Preface to Herschel and South's Observations of Double Stars.

After Fraunhofer had succeeded in forming larger and better achromatic object-glasses than had hitherto been thought possible, he chose for a stand one which is in principle identical with the *Machine Parallatique*, only having the telescope hung on one side, exactly as in the portable equatorial of Megnié. To these he applied a very ingenious clock movement, which greatly facilitated the optical use of the instrument, and rendered it a better micrometrical measurer than had previously existed. To prevent the telescope from bending, Fraunhofer applied a system of balance weights, which were, we believe, invented or brought into extensive use by Reichenbach. It would probably have been better if he had made the telescope stiff, by bracing a form, and had omitted the balance weights for the telescope altogether. It is evident, from their construction, that the least jar or roughness in handling the telescope must set the weights in motion, and consequently ruin the action of the object-glass until they come to rest; and it is not worth while to purchase a little useless accuracy in the measurement with the circles at such a cost. There is considerable inconvenience in this construction; for example, in many positions a star cannot be followed from one side of the meridian to the other without bringing the telescope over, that is, turning the polar axis and the telescope each of them half round. This is particularly disagreeable in the measurement of double stars, which ought, if possible, to be observed near the meridian. There is, perhaps, a little more inconvenience in giving small motions to the telescope; but neither this nor the impossibility of using reversed observations in a majority of instances is of much consequence. On the other hand, when the workmanship and material and engineering are good, an instrument of this form may be expected to stand better in adjustment, and to admit of larger dimensions, and to require less room, than any other.

The most celebrated of Fraunhofer's equatorials is one which is erected at Dorpat, and has been described by Professor Struve. ('Beschreibung des grossen Refractors von Fraunhofer,' Dorpat, 1825, folio, with plates.)

Some enormous telescopes have been mounted on this principle: one carrying the largest achromatic telescope we believe in existence, of 14 inches aperture and 25 feet focal length, was erected at Markree Castle, county of Sligo, for E. J. Cooper, Esq., by Mr. Grubb, of Dublin. The tube of the telescope was constructed under the direction of Mr. Cubitt, and is a capital step in the art of applying large telescopes. The form is that of a very long barrel. T bars of wrought iron extend longitudinally from the object to the eye end, the edge bars being directed towards the centre, and these, after they are connected crosswise by strong rings, are covered with iron plate, which is $\frac{1}{8}$ inch thick in the centre and $\frac{1}{16}$ inch at the extremities. The stiffness of this tube is more perfect than would be readily believed without actual examination, and we see no reason to doubt that a telescope, of at least twice these dimensions, may be mounted with success, so far as the tube is concerned, whenever such an object-glass can be procured. In most of the other large equatorials which we have seen, the telescope is the weakest part; and as it is the habit of many observers to move their instruments by laying hold of the eye end, it is desirable, for this and for some better reasons, to have it as stiff as possible. The equatorial erected in 1838 at the Royal Observatory, Greenwich, was also mounted by Mr. Grubb. The object-glass, the definition of which is very good, was made by M. Cauchoix of Paris, and was presented to the Observatory by the late Rev. R. Sheepshanks. It is nearly 7 inches in clear diameter, and of 8 feet focal length. The telescope is on one side of the axis, and is counterpoised by weights on the other, as in Fraunhofer's method. The hour circle and declination circle are of small size and are chiefly used for setting the instrument. In an equatorial made to carry a 20-foot telescope, constructed for the observatory of Cambridge, at the expense of his grace the Duke of Northumberland, and of Ramsden's form, though with many peculiarities and improvements, Mr. Airy has employed a square wooden tube. Mr. Dollond has made several equatorials on Sisson's construction, which answer very well. The polar axis in these is square, and composed of four strong slabs of wood, making a sort of tube, a little tapered towards the extremities. This is found to be abundantly stiff and firm, at least up to the dimensions which have been tried, namely, for telescopes of from 10 to 12 feet focal length.

Among the astronomical instruments in the Great Exhibition of 1851 were several equatorials, which are minutely described in Mr. Glaisher's masterly report (Class X.). We select a few particulars. In Mr. Ross's large equatorial, the telescope had an aperture of $11\frac{1}{8}$ inches, and a focal length of 18 feet. The hour circle was 2 feet 8 inches in diameter, and the declination circle 2 feet 8 inches. The instrument was supported on a round cast-iron pillar, 10 feet 9 inches in height, 2 feet 8 inches in diameter at the bottom, decreasing to 1 foot at the top, and formed of two portions, fastened together at the height of 4½ feet from the bottom of the base by eight screw bolts and nuts passing through flanges 3 inches in width from the shafts of the column, thus affording the means of an approximate meridian adjustment; the base of the pillar was 9 feet in diameter. The polar axis was of cast iron, 6 inches in diameter and 5 feet in length, connected to the declination axis by a flange 18 inches in diameter. The inner male declination axis is 3½ feet long between its bearings, and the outer or hollow axis was 7 inches in diameter, and both of cast iron. The inner axis and its flange formed one casting with the central hollow cylinder, to the flanges of which the corresponding gun-metal flanges of the telescope were bolted. The tube was of copper. The fitting bearings of the declination axis were cylindrical, and the axis was secured by a steel collar, 4 inches in length, fastened by cross pins to the male centre, at the end to which the circle was fixed. In the inner axis there was a counter-sunk cavity to receive this collar, and a second similar cavity of large diameter to receive a steel plate fastened against the end of the steel collar by eight steel screws, by which means the end-strake of the axis was adjusted. The declination circle was of gun-metal, regulated by an endless screw with an excentric lever attached to a dove-tail slide for gearing, and a pair of bevelled wheels at either end for Hooks' joint adjusting rods. There were also two other radial arms with clamp screws for securing the telescope to the circle. The upper part of the polar axis fitted into a coupling-block, with a hemispherical bottom, supported by an angular projection from the top of the pillar, which had a corresponding cavity, the whole being bound together by bolts and nuts with spherical faces, bearing in corresponding cavities their washers; the bolts passing freely through the holes. The lower end of the polar axis consisted of a hemisphere of hardened steel, bearing on a hardened steel die, surrounded by an oil-cup attached to dove-tail slides, with motions in rectangular directions, supported by a very strong bracket projecting from the main column and applicable to the final adjustment of the polar axis. The hour-circle was moved by a weight and train of wheels, regulated by a Siemen's governor, the ball being suspended by four springs.

---

* Hooke asserts that a clock with a circular pendulum was invented by him in 1665, and complains that Huyghens had published a description of this (in 1674) "without naming him at all as concerned therein." Huyghens says that he invented the clock with a circular pendulum about the same time that he applied the oscillating pendulum, that is, sixteen years before the date of his book, and that several clocks of this description had been been made, "non sine successu," in the mean time. Both Hooke and Huyghens promised to give a complete description of this clock at another opportunity.

Mr. Simms exhibited an equatorial generally of the Fraunhofer form, the only peculiarity being in the declination axis, which was not covered up, but open and exposed between its two supports. The open part was cylindrical, and could be set horizontal by a striding level, similar to that of a transit instrument. Mr. Simms had also a small equatorial, adapted to the latitude of London, but without clock motion. The instrument was said to be inexpensive, and, considering its size, was effective. Mr. Dollond exhibited a portable equatorial supported on a strong folding tripod with divided circles, a finder, levels, and eye-pieces. The instrument was said to be well adapted for seeking for comets. Merz and Sons (Bavaria) had an equatorial with the polar axis adjustible within certain limits, so as to adapt it as a portable instrument, and to be applicable to different latitudes within those limits. The focal length of the telescope was four feet, and the object-glass had an aperture of four inches,—unusually large for this size of telescope, but, by admitting a large pencil of light, adapting it for faint objects.

In mounting a large telescope equatorially, it is not expedient to rest the pivots on small superficial bearings, or to relieve the weight by friction rollers, unless the axis of the rollers be made large. It appeared, in Mr. Cooper's equatorial and elsewhere, that when a heavy pressure was laid on a small bearing, the surfaces did not slip freely, but clung together as it were, causing small oscillations about the position of rest. Again, great care should be taken in following Sisson's construction, or that which we have described as Ramsden's, to provide against any twisting in the axis; simple flexure being of little importance. In Sisson's construction, the junction of the telescope and its cross axis should be very firm; in Ramsden's, the union of the two sides of the polar axis with the base should be such as to prevent all wriggling; and in both, the telescope ought to be very stiff, if it is likely to be roughly handled. To Ramsden's we should apply steadying rods. It is also better to rest the pivots of the declination axis in Ys than in collars; but if a collar is preferred, it should be formed of an upper and lower half, which can be adjusted to clasp the pivot close when the collar wears loose. After all possible precautions, accuracy is not to be expected from a large equatorial, when used as an instrument measuring with its circles, compared with those of moderate size. The equatorial by Troughton, at Armagh, carries a telescope of only 42 inches focal length and 2¾ inches aperture, with an hour circle of 5 feet, and yet the telescope is more powerful than the circles used. Large equatorials are required whenever optical power is wanted, as in the examination of nebulæ, noting occultations, &c., where the micrometer is alone required for measurements, as in observations of double stars, or determinations of the diameters and forms and constitutions of planets, and investigation of the systems of those which have rings, satellites, &c. In these respects Lord Rosse's large reflector erected at Parsonstown Castle, Ireland, deserves especial notice. The clear aperture is 6 feet, and the magnitude of reflecting surface is 28·274 square feet. Though used as a Newtonian telescope, the apparatus of suspension is so arranged that the instrument must be worked as an equatorial. [TELESCOPE.]

The adjustments of an equatorial instrument are easy enough to a person tolerably familiar with the management of other astronomical instruments; and the corrections which are to be applied to observations made with an unadjusted equatorial, ought not to present any difficulty to an astronomer acquainted with spherical trigonometry, and with the ordinary rules for determining the value of the coefficients. Still, as there are many persons who possess equatorially-mounted telescopes, and have not the knowledge or even the leisure to understand this subject thoroughly, we shall proceed to give directions which will enable any one to adjust his instruments with more than sufficient accuracy and without trouble.

We suppose the latitude of the place and the direction of the meridian to be approximately known; and we shall speak as if the instrument showed north polar distance, and the hour circle, when the sun is observed, read as an ordinary clock. Let the polar axis be placed nearly in the direction of the poles of the heavens. The adjustments proceed in the following order:—1st. The polar axis is placed at the altitude of the pole. 2nd. The indices of the declination circle are made to read 0, when the telescope points to the pole; this is sometimes called "correcting the collimation in declination," or "north polar distance." 3rd. The pole of the instrument is brought into the meridian, and as it has already been set at the proper altitude, it now coincides with the pole of the heavens. 4th. The line of sight of the telescope is made perpendicular to the declination axis; this is similar to the collimation adjustment in the transit. 5th. The declination axis is placed exactly at right angles with the polar axis, if the means of adjustment are allowed. 6th. The hour circle is made to read 0^h, when the telescope is in the meridian of the place.

1st. Observe any known star in north polar distance, and then turning the polar axis half round, observe the same star again; these observations should be as near the meridian as possible; and if the instrument is much out of adjustment, the star should not be very near the pole. Take the mean of the two observations, which is the distance of the star from the pole of the instrument, correct it for refraction, and then compare the result with the true north polar distance given by the Nautical Almanac, or computed from a standard catalogue. If the star be above the pole, and the instrumental north polar distance be *greater* than the true north polar distance, it is clear that the instrumental pole is farther from the star than is the pole of the heavens, or that it is too *low;* but if the instrumental north polar distance be *less* than the true north polar distance, then the pole of the instrument is too *high.* Correct this error by the proper screws for raising or depressing the polar axis, which may be done at once if the thread of the screw and the length of the polar axis be known.

2nd. Take half the difference of the above two observations; this is the index error of the declination verniers or microscopes, and they must be moved just so much in the proper direction by their adjusting screws, and set, if there be more than one, at their proper distances. The polar distance read off will now correspond with the true *instrumental* polar distance in every position of the instrument. Several pairs of observations should be taken, in order to ascertain these two errors with great accuracy before they are finally corrected and considered to be settled.

3rd. Turn the instrument six hours from the meridian either way, and observe the north polar distance of any known star not very near the pole nor yet near the horizon. Correct this for refraction. We will suppose the star observed to the east of the meridian, and that the observed distance exceeds that given by the Nautical Almanac or the standard catalogue; then the pole of the instrument is further from the star than is the pole of the heavens, or is to the west of its proper place; hence the upper pivot must be shifted to the east, or the lower pivot to the west, the proper quantity. In this, as in the former case, several stars should be used for greater accuracy; but there is no necessity for reversed observations, as the index error is already supposed to be corrected, or at least to be known, and therefore easily allowed for. The polar axis is now adjusted both in altitude and azimuth.

4th. Observe the transit of an equatorial star over the middle vertical wire or mean of the wires, note the time, and read off the verniers of the hour-circle. Turn the polar axis half round, and observe the same star a second time exactly as before. Now if the time between the two observations corresponds exactly to the difference between the two readings of the hour-circle, all is right; if not, it is evident that one of the transits has been observed too early, and the other too late, on account of the erroneous position of the wires. If the time elapsed be *greater*, by 6^s suppose, than the difference of the hour-angles, the first transit has taken place 3^s too early and the second 3^s too late. Set again upon the star and observe how far it appears to travel in 3^s; and then if the instrument is in the first position, move the wires this quantity in R.A. with the star, and *vice versâ* if the instrument be in the second position. The rule *mutatis mutandis* will apply to any case, and where there are no means of measurement and no mark, the adjustment must be made by repeated trials. With a micrometer in R.A., or with a mark, it may be performed with accuracy at once.

5th. This adjustment may be performed in two ways, either astronomically, or, when there is a level attached to the declination axis, mechanically. In the first case observe the transit of a star, not less than 45° from the equator, in reversed positions of the polar axis, exactly as in determining the collimation. Since an elevation of the west end of the declination axis causes the line of sight to describe a circle to the east of the pole, all the transits observed in that position will be too early, and *vice versâ* all will be too late when the east end is high. Again, if the west end is too high before reversing, the east is too high after reversing; so that an error of inclination has a different effect upon observations in reversed positions, and thus the interval is increased or diminished by twice the error of a single observation. The law of the error is that it varies as the tangent of the star's declination. Suppose the star observed to have 45° declination, and that the interval between the observations is, according to the clock, $3^m\ 8^s$, and according to the hour-circle only 3^m. It is evident that the first observation was 4^s too early and the second 4^s too late, and since the tangent of declination $=1$, the west end of the declination axis was elevated 1′ in the first position and depressed 1′ in the second. If the star had had any other declination, as δ, the 4^s should have been divided by the tangent δ before it was converted into an arc. There is a second astronomical method which may perhaps suit some observers better, though less satisfactory, as it depends entirely on the accuracy of the position of the polar axis in azimuth. Having clamped the hour-circle very firmly when the instrument is nearly in the meridian, observe the transits of some stars near the equinoctial and others distant from it. If the distant stars agree in giving the same clock error with the stars near the equinoctial, the declination axis is rightly placed in respect of inclination; but if not, then, taking the clock errors from the equatorial stars, it will readily be seen whether the stars between the pole and the equator pass too early or too late. If they pass too early, the west end is high, if too late, the east end is high, and the inclination of the axis in arc is equal to $15'' \times \frac{\textit{error in time}}{\tan.\ \delta}$. In both these astronomical modes no error of collimation is supposed to exist.

The mechanical adjustment varies a little according as the level is applied. [LEVEL.] This may rest with its Ys upon the pivots of the declination axis, as in the altitude and azimuth circle [CIRCLE] and transit [TRANSIT], or hang from two cylinders, which, being fixed on the declination axis and parallel to it, project so far as to allow a level suspended from them to swing clear of the axis in all positions of the telescope. Place the declination axis horizontal by the level, and read the hour-circle; turn the polar axis half round, and place the declination axis horizontal again, and again read the hour-circle. If the readings are the same (or where the graduation is to 24^h, differ exactly 12^h) in both positions, the declination axis is adjusted; but if not, place the hour-circle half way between the positions it actually has and that which it ought to have, and make the declination axis horizontal by raising or depressing the screws which adjust it. The swing level requires a preliminary adjustment, that of making the cylinders from which it hangs parallel to the declination axis, which is to be performed thus: By turning round the telescope, bring the level directly below the declination axis; and by turning round the polar axis, bring the bubble into the middle, and clamp the hour-circle. Turn the telescope half round, when the level will be directly above the declination axis. Then, if the bubble run towards one end, bring it half way back by the screws which raise one of its supports, and the other half by the tangent screw of the hour-circle. The process must be repeated till it is satisfactory. The level itself is to be adjusted, as all levels are, by reversing it end for end on its cylinders.

6th. The instrument having been placed in the meridian, and clamped there, the hour-circle verniers, or microscopes, are to be set to mark 0^h. If the observer have the means of getting his time with tolerable accuracy, he may perfect his adjustment thus: Clamp the instrument approximately in the meridian, observe the transit of one or more known stars not far from the equator, and correct the time of observation for the known error of the clock. Then, as the right ascension of the star = true sidereal time of observation ± true hour angle from the meridian, the true hour angle is known, and the verniers, or microscopes, may be set to mark it. Or the declination axis may be set horizontal by the level, when, if the previous adjustments have been properly performed, the instrument is in the meridian, and the verniers or microscopes set to mark 0^h.

By attending to these rules and repeating the operation (stars near the pole may be safely used the second time), the instrument will be found to be very nearly in adjustment, and it is desirable that it should be so. The computation of instrumental corrections is tedious and perplexing, and most ordinary observers would blunder in the attempt; after all, the results of an equatorial, used as an *independent* instrument, are little to be relied upon. Except for observations of N.P.D. near the meridian, in reversed positions of the polar axis, as described in the first and second adjustment, the best equatorial must always be inferior to an indifferent vertical circle. Out of the meridian the careful observer will always use it as a differential instrument, which is its peculiar destination.

In the rules above given it will be remarked that the observer is directed, in every case but the 3rd, to place the instrument nearly in the meridian. This is the most favourable position of the instrument in its ordinary construction as regards symmetry and strength. Besides this advantage, the computation for refraction in or near the meridian is very simple, being the same in N.P.D. as in zenith distance,* while it is 0 in R.A. For the third adjustment, the formula of computation, where great accuracy is not required, is refraction = 57″.7 × tang. N.P.D. of star, or the ordinary formula for refraction in altitude, using the star's polar distance instead of its zenith distance. The formula is more accurate the nearer the star is to the pole, but in these latitudes will be sufficiently correct if the N.P.D. do not exceed 60°. An adjustment within 10″ may be considered to be close enough for all practical purposes.

The equatorial, being thus adjusted, is ready for use, and may be turned upon any star at pleasure. Suppose it be required, at sidereal time $13^h\ 14^m$, to find a star, the R.A. of which is $17^h\ 33^m$, N.P.D. 67° 28′. As the R.A. of the star is greater than the sidereal time, the star has not yet come to the meridian, or the hour angle is east. Subtracting $13^h\ 14^m$ from $17^h\ 33^m$, we have $4^h\ 19^m$ for the east hour angle. Turn the telescope to the east, and set to the reading $12^h - 4^h\ 19^m$, or $7^h\ 41^m$ of the hour-circle;† then set the declination circle to 67° 28′ N.P.D., and the star will be nearly in the centre of the field. With a little practice an observer can make an approximate allowance for refraction by taking away a few seconds from the hour-angle, and a minute or two from the N.P.D. If the star be very near the horizon, the usual course is to put on a low power to the telescope, and, having thus found the star, to set the telescope exactly upon it, and then to apply the power best adapted to the observation in view. The telescope being clamped in N.P.D. will follow any star by moving the instrument round in R.A. with an angular velocity equal to the apparent motion of the heavens. This motion is best given by clockwork, which is now pretty generally in use; and, indeed, for the measurement of double stars, the observation of occultations, eclipses of Jupiter's satellites, and all optical and micrometrical purposes, is nearly indispensable.

It is not necessary actually to correct each adjustment before proceeding to the next, and the errors in R.A. may be determined at the same time with those in N.P.D. by any person who understands the mysteries of a simple equation and the *law* of the errors. As the subject has not, we believe, been treated very satisfactorily, at least in any English publication, we shall proceed to deduce the errors and corrections of an equatorial every way out of adjustment from observations. We take as an example July 8, 1836.

Star.	Face of Dec. Circle.	Sidereal Time.	Observed Hour-Circle.	Observed N.P. Distance.
		h. m. s.	h. m. s.	° ′ ″
β Urs. Min. . .	E.	14 53 14·5	0 2 56·6	15 15 15
Ditto	W.	15 4 53·8	0 14 16·8	15 8 55
α Urs. Maj. . .	W.	17 1 8 0	6 8 45·8	27 13 52
δ Aquilæ . . .	W.	19 18 11·8	0 2 15·2	87 11 21
Ditto	E.	19 29 41·3	0 13 48·4	87 17 36

The sidereal time is corrected for the error of the clock, and the mean readings of the hour-circle and declination circle are corrected for refraction.

The instrumental N.P. distances, instrument east, are larger than those, instrument west, and the difference is

for β Ursæ Minoris .	6′ 20
for δ Aquilæ. . . .	6 15
Mean . . .	6 17·5=double index error.

or the index error is 3′ 8·7″ to be *subtracted* inst. E., and *added* inst. W.

Again taking the mean of the N.P.D. inst. E. and W.

	Instl. N.P.D.	N.A. Alm.	Differ.
	° ′ ″	° ′ ″	′ ″
β Ursæ Minoris .	15 12 5·0	15 10 17	1 48
δ Aquilæ. . . .	87 14 28·5	87 12 23	2 5·5
Mean			1 56·7

and as the instrumental exceeds the true N.P.D. and both stars are above pole, it follows that the pole of the instrument is *below* the pole of the heavens.

α Ursæ Majoris is nearly in the 6 hour meridian west, and therefore in a proper position for determining the azimuthal deviation of the pole: we shall suppose it is exactly at 6 hours from the meridian.

---

* The refraction in N.P.D. may be taken from any of the tables, as the zenith distance is equal to the N.P.D. of the star, after subtracting the co-latitude for the upper culmination and adding it for the lower. The correction is to be added to the instrumental N.P.D., when the star is south of the zenith or *sub polo*, and to be subtracted when the star is between the pole and the zenith.

† The hour angle reckoned from the meridian is always the difference between the sidereal time and the R.A. of the star. When the sidereal time is less than the R.A. of the star, add 12h to the sidereal time, and then, after subtracting the R.A. of the star, you have the reading of the hour-circle, according to the graduation into two twelves. If the graduation is from 0h to 24h, add 24h instead of 12h to the sidereal time, and subtract the R.A. as before.

Correcting for the index error, we have 27° 16′ 52″ + 3′ 9″ = 27° 20′ 1″, for the instrumental N.P.D., whereas the Nautical Almanac gives the true N.P.D. of this star = 27° 21′ 42″. The difference is 1′ 41″, which is the quantity by which the pole of the instrument is to the west of the pole of the heavens. We have therefore determined the error of the polar axis and the index error of the declination circle, which may be corrected, if necessary, by altering the screws.

δ Aquilæ is very near the equator, and therefore proper for determining the error of collimation in R.A. The sidereal time between the observations is $11^{m}\ 29^{s}{\cdot}5$, and the difference between the readings of the hour circle is $11^{m}\ 33^{s}{\cdot}2$, hence the error of collimation in the equator is $\frac{3^{s}{\cdot}7}{2}$ or $1^{s}{\cdot}85$, which is to be added to the hour angle of the observation, Inst. W., and subtracted, Inst. E. For stars out of the equator this correction is to be multiplied by the secant of declination. Now the secant of declination for β Ursæ Minoris = 3.82, hence the effect of collimation for this star $= 3{\cdot}82 \times 1^{s}{\cdot}85 = 7^{s}{\cdot}1$ nearly, and subtracting this from the hour angle of the first or E. observation, and adding it to the second or W. observation, we have E. $0^{h}\ 2^{m}\ 49^{s}{\cdot}5$ and W. $0^{h}\ 14^{m}\ 23^{s}{\cdot}9$ for the hour-circle readings corrected on account of collimation. The difference between these is $11^{m}\ 34^{s}.4$, while the sidereal time elapsed is $11^{m}\ 39^{s}{\cdot}3$, and half the discordance between these two results $\frac{4^{s}{\cdot}9}{2}$ or $2^{s}{\cdot}45$ is the error due to the inclination of the declination axis. As this error varies as the tangent of declination, which in β Ursæ Minoris = 3·69, the error for any other star $= \frac{2{\cdot}45}{3{\cdot}69} \times \tan.\ \delta = 0^{s}{\cdot}7 \times \tan.\ \delta$ nearly. It is evident that this correction is to be subtracted from the instrumental hour angle, Inst. E., and to be added, Inst. West. The sign is to be changed if the correction is to be applied to the sidereal time of the observation, that is, if the observer wishes to adjust his instrument (when it is E., for instance), he must make the time of passage later than it is, which is done by lowering the west end of the declination axis. In this case the quantity is $0^{s}{\cdot}7$ or $10''{\cdot}5$.

No considerable error arises from omitting the effect of inclination upon δ Aquilæ in the above example; but it is more satisfactory to deduce both the coefficients of collimation and inclination at once.

Let c be the constant of the correction for the collimation and i for the inclination, both + when Inst. W. and when the correction is to be applied to the hour angle; then substituting the numerical values of the secants and tangents of the two stars, we shall have for the corrected hour angles.

		h	m	s
β Ursæ Minoris	E.	0	2	$56{\cdot}6-3{\cdot}82c-3{\cdot}69i$
„	W.	0	14	$16{\cdot}8+3{\cdot}82c+3{\cdot}69i$
Difference . . .			11	$20{\cdot}2+7{\cdot}64c+7{\cdot}38i = 11\ \ 39^{s}{\cdot}3.$
δ Aquilæ,	W.	0^{h}	2^{m}	$15^{s}{\cdot}2+1{\cdot}00c+0{\cdot}05i$
	E.	0	13	$48{\cdot}4-1{\cdot}00c-0{\cdot}05i$
Difference . .		0	11	$33{\cdot}2-2{\cdot}00c-0{\cdot}10i = 11^{m}\ 29^{s}{\cdot}5,$

which give for the determination of c and i

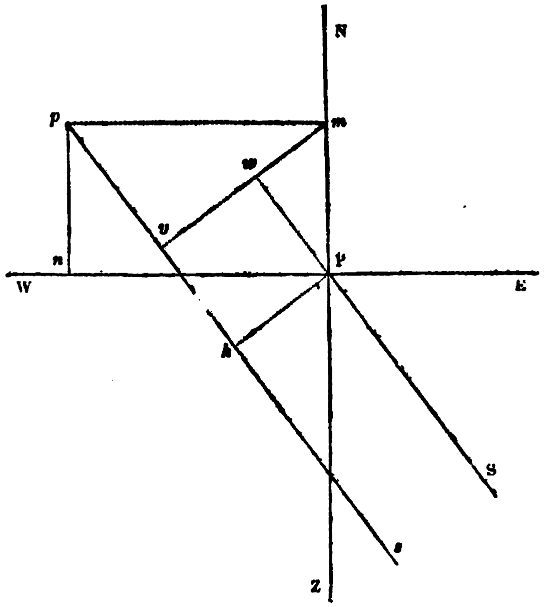
$$7{\cdot}64c+7{\cdot}38i=19{\cdot}1$$
$$2{\cdot}00c+0{\cdot}10i=\ 3{\cdot}7$$

from which i is found $= 0{\cdot}71$ $c = 1{\cdot}81$ nearly as before.

In this way, by forming an equation for each star, and combining all the observations in which i has a small coefficient into one equation (when stars have south declination, or are *sub polo*, the coefficient is negative), and those where the coefficient of i is large into another, the value of i and consequently of c, may be determined with great accuracy. It is not absolutely necessary that the observations for deducing these corrections should be near the meridian, but it is desirable that as little time as possible should elapse between each of the pair of observations, on account of the variation of refraction and of the effect of polar error, if that be considerable. As a general rule, it would be well to keep within a few minutes of the meridian, for in the above example the variation of refraction in β Ursæ Minoris is $0^{s}{\cdot}5$, while the variation of the effect of polar error is no less than $1^{s}{\cdot}3$. Besides, the instrument is always most perfect near the meridian, and is to be used there when possible.

If the errors be corrected by adjustment, the index error of the hour-circle is simply the difference between the observed hour angle and the true hour angle. Or supposing the true sidereal time unknown, the index error must be determined by a level, as we have described above, after placing the declination axis horizontal. But if instead of actually adjusting the instrument, the errors are noted and corrections applied, we have yet to compute the effect of polar deviation upon the observations in R. A. before the index error can be correctly obtained. In order to do this, we must consider the polar deviation more minutely; and as we have reason to think that from a want of skill in detecting the polar error of an equatorial, or in applying the corrections which depend upon this error to observations, especially in R. A., observers have been led to impeach too hastily the character of instruments, we shall explain this part of the subject very fully.

Let P be the place of the pole of the heavens, and p that of the pole of the instrument when prolonged indefinitely, as seen on the sphere of the heavens by a spectator outside; N P Z the meridian of the place, which, when produced towards Z, passes through the zenith and the south point of the horizon; E P W the 6-hour meridian, which passes through the east and west points of the horizon. Let fall $p\,m$ and $p\,n$ perpendicular on Z N and E W, and let $p\,m$ or P $n = x''$ and $p\,n$ or P $m = y''$. It is presumed that the index error of the declination circle has been obtained by reversed observations, which is indeed the universal rule, and therefore that the observed N.P. distances, corrected for index error and refraction, express the actual distances of the stars from p.



Let a tolerably distant star be observed, the place of which is in the direction of $p\,s$ when continued; draw P k perpendicular to $p\,s$, and also P S from the true pole towards the star, hence Z P S is the true hour angle of the star.

Then, since the instrument is nearly in adjustment and the star not very near the pole, P S and $p\,s$ are nearly parallel, and P k is perpendicular to both, hence the distances of the star from P and k are equal, and the effect of polar error on the N.P.D. of the star is to make its instrumental polar distance too large by $p\,k$. Drawing $m\,v$ perpendicular, and P w parallel to $p\,s$,

$$p\,k = p\,v + v\,k \text{ or } \mathrm{P}\,w$$
$$= p\,m \times \cos.\ m\,p\,v + \mathrm{P}\,m \times \cos.\ m\,\mathrm{P}\,w;$$

or, since $m\,p\,v$ is the complement of $n\,p\,v$, which is = Z P S, and m P w = Z P S,

$$p\,k = x'' \times \sin.\ \text{east hour angle} + y'' \times \cos.\ \text{east hour angle}.$$

From this formula, if x and y be known in quantity and direction by observations in the meridian and at six hours from it, the value of $p\,k$ may be computed and applied as a correction to the observed N.P.D. of any star, and the observed hour angle will serve for the computation.

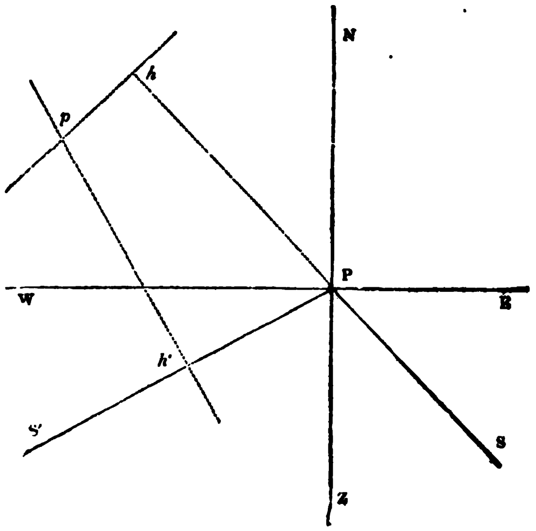
In practice we have found it sufficiently accurate to draw $p\,n$ P on a scale where seconds are visible,—that is, equal to about $\frac{1}{50}$ inch,—and then making the angle $n\,p\,s$ equal to the observed hour angle, and letting fall P k perpendicular on $p\,s$ to ascertain the value of $p\,k$ by compass and scale. It is not possible to commit an error of more than 2″ or 3″, which is generally of little importance; and besides the superior rapidity of the operation, there is no danger of confounding the *sign* of either part of the correction, whether the star be above or below pole, which even careful and experienced computers can scarcely at times avoid. In any case the graphical process will afford a very useful check.

The effect of the displacement of the polar axis upon the readings of the hour circle may easily be gathered from the same figure. Suppose the two lines P S and $p\,s$ to be continued till they meet at the star, and to be produced, if necessary, until they cut the equator in Σ and σ. The reader may imagine or draw the figure. If the star be north of the equinoctial, the lines P S Σ and $p\,s\,\sigma$ cross at the star, and the hour angle corresponding to p is to the east, and greater than the hour angle corresponding to the true pole P. Hence the reading of the hour circle is too small in the case represented in the figure, or Σσ is to be added to the reading of the hour circle. Also, since $\sigma\Sigma : \mathrm{P}k :: \sin.\ \delta : \cos.\ \delta \therefore \sigma\Sigma = \mathrm{P}k \times \tan.\ \delta.$ Again,

$$\mathrm{P}k = mv - mw$$
$$= pm \times \sin.\ mpv - \mathrm{P}m \times \sin.\ m\mathrm{P}w$$
$$= x'' \times \cos.\ \text{east hour angle} - y'' \times \sin.\ \text{east hour angle}.$$

The reader will have no difficulty in following out the rules with regard to the signs of the correction in each particular case, but it will be much safer and quite accurate enough to take the value of P*k* from the figure and to multiply it by $\frac{1}{15}$ tan. δ for the correction. As a practical direction we have found this convenient. Join P*p*, and produce it both ways. Then according to this figure, the correction is additive to the hour circle reading for all stars having north declination which are observed on the south side of P*p* produced, and *vice versâ* for stars on the north side. The tangent of declination is negative when the star is south of the equinoctial, and the rule is reversed. There is no correction for stars in the direction of P*p*, that is for stars having an east hour angle from the south or a west hour angle from the north, such that its tangent $= \frac{x}{y}$. After this correction has been applied, the index error of the hour circle may be deduced in the manner pointed out.

It sometimes happens that an observer, from carelessness or want of time or knowledge, does not determine the position of the pole of the instrument by the best means, viz., by observations in the meridian and at six hours from it, but that this position is to be deduced from a higgledy piggledy mass of observations made in different parts of the heavens. To form equations such as we have just given for each observation, and to solve them by the method of minimum squares, might possibly be the most accurate mode; but the labour would be very great, and on such an object very much misspent. We have found the graphical process quite sufficient, and it has the further advantage of exhibiting to the eye those observations which, from their extravagance, are probably errors in bisecting the star or in reading off the verniers. Suppose such a set of observations to be given for reduction. Draw W E and N Z, at right angles to each other, and intersecting at P, and then draw from P lines such as PS, PS′ for each known star observed, making the angles SPZ, S′PZ equal to the observed hour angles of the stars. If the instrumental polar distance be less than that of the catalogue, as in S′, take P *h*′= the difference; if the instrumental distance be greater, as in S, prolong SP and take P*h*= the difference. Through *h* and *h*′ draw perpendiculars to PS and PS′, and these will intersect at *p*, the place of the instrumental pole. Repeating this process for each known star, the eye will show pretty nearly where *p* should be chosen among the various intersections. The place of *p* being determined, the observations of an unknown star or comet may be corrected as shown above; and by dropping perpendiculars on PW and PN, the azimuthal and vertical errors of the pole of the instrument may be determined.



It seems scarcely necessary to caution any person into whose hands such observations may come, against relying upon intersections which are made at very acute or very obtuse angles. If, for instance, we were to attempt to deduce the place of *p* as to azimuth by a pair of observations near the meridian, or its place as to altitude by observations near the 6 hour meridian, we should only have our own folly to blame for the inaccuracy of the result. From the nature of the case, the unavoidable errors of observation would be multiplied by the process, and a result of any kind might be obtained, just as by observing the sun near noon for time and near the prime vertical for latitude, a sailor might cause his sextant to be guilty of any assignable error. This is evident from the form of the analytical equation, but any non-algebraist may satisfy himself by drawing lines PS and PS′, making an angle of 5° or 10°, and by finding what the effect of an error of 10″ in the observations will be on the position of *p*. If three observations of stars without reversion should be employed, and the index error of the declination circle be deduced at the same time, the blunder will be complete.

Though the errors of an unadjusted equatorial may be detected and the corrections rigorously computed, it would be an abuse of time and calculation to do so. In two of the ordinary constructions of the instrument and probably in the third, the instrumental errors are not and cannot be expected to be accurately the same in all positions of the instrument. In those equatorials of Ramsden's construction which have five feet telescopes and declination circles of three feet diameter, variations of adjustment between the meridian and six hours from it may be expected to amount to 10″ or 20″, and in the largest equatorials, which are necessarily more imperfect, discrepancies of 1′ or even 2′ may arise. We shall now point out the rational mode of using an equatorial instrument, when the object is to determine the place of any phenomenon in the heavens.

The first thing is to adjust the instrument with great care, and especially to make the pole of the instrument agree with the celestial pole. The permanence of this adjustment depends solely upon the steadiness of the upper and lower supports, which should therefore be fixed very solidly. This being done, suppose a comet is to be determined. Turn the telescope upon it, and having clamped the hour circle very firmly, note the transit of the comet over the vertical wires, bisecting it at the same time in N.P.D. by the horizontal wire. Wait till some other star passes over the field, note its transit, and bisect it in N.P.D. by moving the micrometer screw only. In this case the declination circle is supposed to be firmly clamped between the observations. Then the difference of the times of observation gives the difference of R.A. between the comet and star, and the difference in declination is taken from the micrometer. It is the same thing, of course, whether the star precedes or succeeds the comet. Observations of this kind are amongst the most perfect which can be made, for the errors of the instrument being the same in each case, and the refraction almost the same, no error can creep in except that of noting the phenomenon. The star which is sometimes called the *determining star*, or the *star of comparison*, is afterwards observed by meridian instruments, and then the place of the comet is deduced with the greatest accuracy. Frequently, however, there is a dearth of stars of comparison, and the time before a proper star enters the field is too long for the patience of the observer, or he may not have a micrometer. In this case the instrument is kept clamped in R.A., and after observing the comet, the telescope is moved up or down a little, and stars above and below the comet are observed, in R.A. by noting the clock, and in declination by reading the circle. The instrument should then be turned half round in R.A., and the operation repeated. By combining both sets, as good a place of the comet will be deduced as the division of the declination circle will allow. The stars of comparison are taken above and below, so that the mean of the instrumental errors at the stars may be pretty nearly equal to that at the comet, and as the effect in R.A. of an error of collimation or inclination is changed in sign by reversion, it is therefore eliminated from the mean. The instrument must on no account be moved in R.A. between the observation of the comet and the stars of comparison. In this way Halley's comet was observed at Greenwich and Cambridge, the stars of comparison were subsequently observed with the meridan instruments, and the apparent places of the comet finally settled. The details will be found in the observations of the respective observatories for the year 1835.

If the utmost accuracy be not required, it is sufficient, after careful adjustment, to note the transit of the comet over the vertical wires, and to read off the declination and hour circle, and then turning the instrument upon one or more neighbouring stars, to observe them in like manner. The nearer the stars of comparison are to the comet, the greater probability there is that there is no change, or only a slight change of instrumental error in moving from one to the other. This mode of observation, however, is only to be tolerated in cases of necessity, when, either from haste or uncertain weather, the observer cannot wait for stars coming to the same meridian with the comet.

Suppose the following observations to have been made of *Arcturus* and of an unknown star or comet, after correcting each for refraction.

	Time by Clock.			Hour Circle.			North Polar Dist.		
	h.	m.	s.	h.	m.	s.	°	′	″
Arcturus	17	17	9·9	3	10	15·5	69	54	46
Comet	17	27	11·5	2	50	38·1	62	11	1

To determine the index errors of both circles by Arcturus, we have

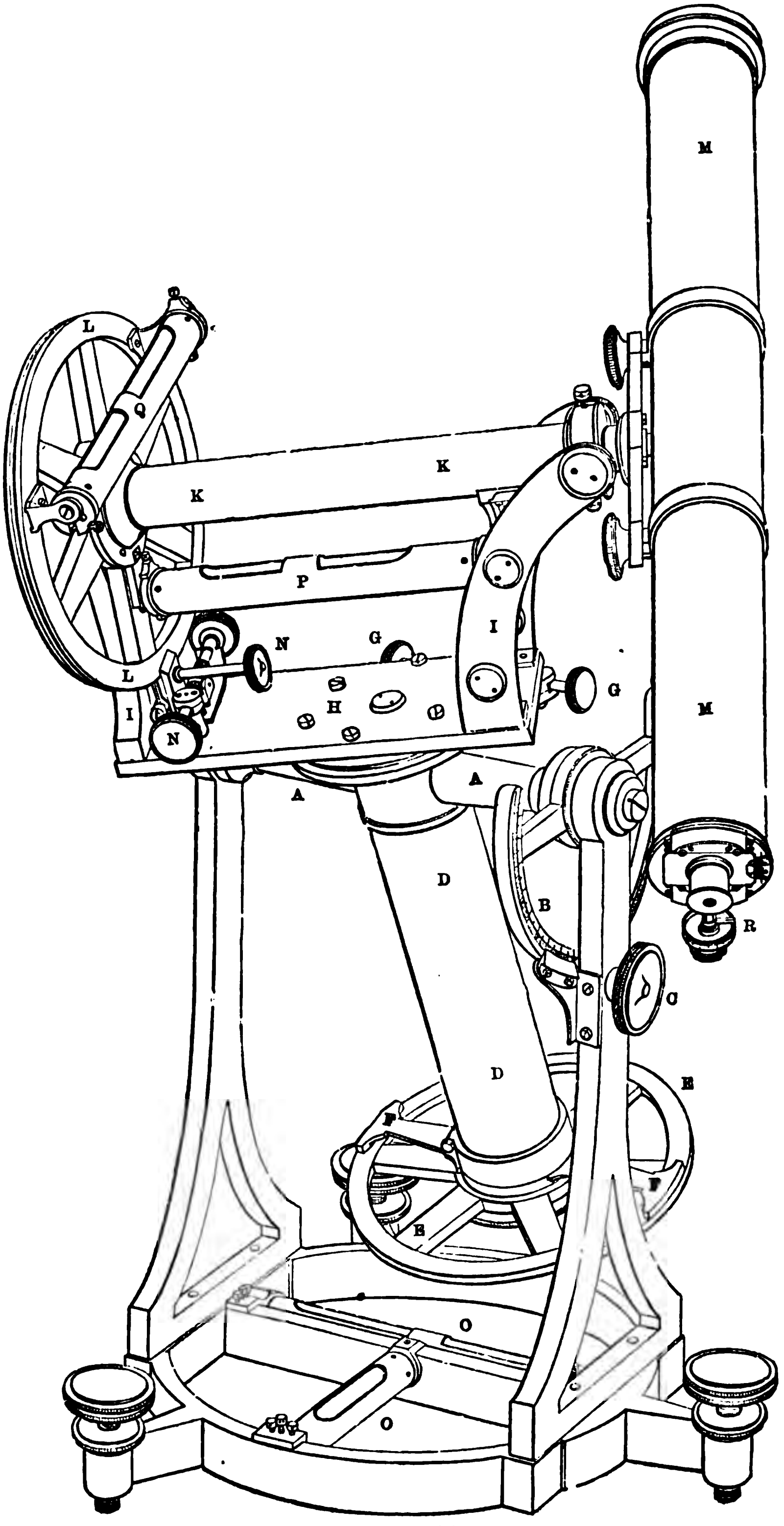
	h.	m.	s.		°	′	″
Time by clock	17	17	9·9	Instruml. N.P.D	69	54	46
Hour angle west	3	10	15·5	Ditto Naut. Alm.	69	57	37
Instrumenl. R.A.	14	6	54·4	Instruml. N.P.D. *too small*		2	51
R.A. Naut. Alm.	14	8	10·6				
Instrumenl. R.A. *too small*		1	16·2				

Applying these corrections to the observations of the comet, we have

	h.	m.	s.		°	′	″
Time by clock	17	27	11·5	Instrumentl. N.P.D.	+ 62	11	1
Instl. hour angle	2	50	38·1	Correction	+	2	51
Instl. R.A. comet	14	36	33·4	N.P.D. . .	+ 62	13	52
Correction . .	+	1	16·2				
True R.A. comet	14	37	49·6				

The star of comparison is, in this case, much too distant both in R.A. and N.P.D.; and the index error ought to be determined by stars above and below the comet, and preceding and succeeding it. Also, after the observations have been made in one position of the instrument, it ought to be turned half round and the observations repeated; but the mode of ascertaining and applying the corrections is the same, and needs no further explanation.

The accompanying figure represents the *portable universal equatorial* as constructed by Troughton (a drawing and description of a similar instrument, under the title of *Fayrer's Equatorial* will be found in



The Equatorial,

Rees's 'Cyclopædia,' article EQUATORIAL). The lower part or stand rests on three foot-screws, and needs no description. The upper part is moveable on a cross axis A A, on which it is balanced; and when the polar axis is set at the proper inclination by the latitude semicircle B, the clamp C retains it there. The polar axis consists of an outer tube, D D, forming one piece with the horizontal axis above-mentioned, and of an interior axis which turns freely within the tube as in a socket. This latter axis carries the hour circle, E E, the verniers, F F, being fixed to the tube. The clamp and tangent screw of the hour-circle are partially seen at G G. The upper plate H is fixed on the inner axis, and revolves with it. Two pieces, I I, rise from this plate, and carry the collars within which the cross or transit axis, K K, works. The declination circle, L L, and telescope, M M, are fixed to the extremities of the transit axis, the telescope being outside the collar. The declination clamp and tangent screw are seen at N N; the verniers are on the other side. These are attached to the support which rises from the plate H. Two levels are fixed on the lower part of the stand at O O, but they are only to be used for approximate adjustment. A delicate swing level, P, is hung from the transit axis, and a second level, Q, is fixed to the declination circle. The telescope has a micrometer, R, carrying wires for measuring small differences of declination.

It is evident to those who know Fraunhofer's construction, that it is identical with the upper part of this universal equatorial. The suspension and motion of the polar axis and hour circle are the same as in the equatorial made by Troughton for the University of Coimbra. The position of the telescope is that of Megnié and Nairne.

The rules we have already given will enable any one to adjust the universal equatorial; but if the direction of the meridian be known, it is a simpler plan to adjust the instrument as an altitude and azimuth circle, which it becomes when the polar axis is vertical, and then by inclining the polar axis to the latitude of the place, it becomes an equatorial. There is no provision in the instrument itself for moving the polar axis in azimuth. The whole must be turned bodily, and for this purpose some preparation should be made in the stand on which the foot-screws rest.

The following references will be useful to the reader. A clock for carrying an equatorial, constructed by Messrs. Troughton and Simms, is described in the 'Abstracts of the Proceedings of the Royal Astronomical Society,' vol. iii., No. 6, with a wood-cut. This would probably act somewhat more steadily with a horizontal fly-wheel upon the vertical axis, but its performance is very good. An account of the slipping piece and the wire micrometer to be applied to the equatorial for observing double stars, with directions for their use, is given in the appendix to the 'Companion to the Maps of the Stars published by the Society for the Diffusion of Useful Knowledge,' 1836. For the mode of using the equatorial as a measuring circle, see the 'Cambridge and Greenwich Observations' for 1835 and 1836 of Halley's Comet, of the Solar Eclipse, and of the elongation of Jupiter's fourth Satellite; and for the corrections for refraction and parallax, the 'Introduction to the Greenwich Observations,' 1836, to which the reader should look if he wishes to know the best methods of making and reducing astronomical observations in general. Sir George Shuckburgh's 'Memoir' already referred to contains a valuable history of the instrument, though on consulting the authorities, we have been led occasionally to differ from him. A description of Ramsden's *refraction piece* will be found at page 19 of Shuckburgh's paper, along with a collection of tables for computing the effects of refraction and parallax in R.A. and N.P.D. from the data which this ingenious appendage affords. Pearson's 'Practical Astronomy,' vol. ii. p. 517; Littrow, 'Memoirs of the Astronomical Society,' vol. ii. p. 45; Kriel, 'Mem. Ast. Society,' vol. iv. p. 495.

EQUERRIES (from the French *écurie*, a stable), the name given to certain officers of the Royal household in the department of the master of the horse, the first of whom is styled chief equerry and clerk-marshal. Their duties fall in rotation. When the sovereign rides abroad in state, an equerry attends. Officers of the same denomination form a part of the established households of the royal dukes, &c.

EQUIANGULAR, EQUILATERAL, EQUI-CRURAL, EQUI-TANGENTIAL, &c. &c., a class of words beginning with EQUI, which, in composition forms an adjective expressive of the equality of two things spoken of. Thus equiangular means having equal angles, and so on. There is a certain liability to confusion, arising from mistaking between the application of such terms to different parts of the same figure and to different figures. Thus 'an equilateral triangle' must mean a triangle which has three sides all equal. But 'two triangles which are equilateral' may mean two triangles in which every side of the first has its equal among those of the second: the two not being separately equilateral. To avoid this, it is sometimes said that two triangles, such as have just been mentioned, are *mutually* equilateral.

EQUILI'BRIUM (*æqua libra*), a state of rest produced by the mutual counteraction of two or more forces. The science of equilibrium is STATICS.

EQUIMULTIPLES, multiples in which equal numbers of times are taken. Thus *seven* times A and *seven* times B are *equi*-multiples of A and B: a league and a yard are equimultiples of a mile and a foot. The student of the fifth book of Euclid should remember that this word has no singular number: 7 A and 7 B are equimultiples, but 7 A is not therefore to be called *an* equimultiple but *one of the* equimultiples. And the same of the word equal, whether separately or in composition: A and B may be equal lines, but A is not *an equal* line. Equality implies comparison of at least two things.

EQUINOCTIAL, a name given to the equator, from the night being equal to the day when the sun is there.

EQUINOXES, the intersections of the equator and ecliptic; the vernal equinox being that in which the sun is when about to rise into the northern hemisphere; the autumnal equinox being that in which the sun is when about to sink in the southern hemisphere. These terms are relative: for the equinox which is vernal in our hemisphere is autumnal in the southern, and *vice versâ*.

EQUISE'TIC ACID, *Aconitic Acid* ($3HO, C_{12} H_3 O_9$) an acid discovered by Bracconot in the *equisetum fluviatile*, in which it exists combined with magnesia.

This acid may be obtained in small colourless radiating crystals; its taste is sharp, and somewhat analogous to that of tartaric acid: it is unalterable in the air. When heated, it decomposes without subliming, and yields an oily uncrystallisable acid product. It dissolves readily both in alcohol and in water: the solution gives no precipitate either with lime or baryta water, but with acetate of lead and protonitrate of mercury it gives white curdy precipitates: it precipitates the persalts, but not protosalts of iron.

With potash and soda it yields deliquescent uncrystallisable salts; with ammonia, a crystallisable salt. With oxide of zinc, with lime, and magnesia, it forms uncrystallisable transparent compounds, which are unalterable in the air. [ACONITIC ACID; CITRIC ACID.]

E'QUITES (horsemen), the name of an order in the Roman state. Their origin, according to the old tradition, was this:—Romulus having divided his subjects into three tribes, chose from each one hundred young men whom he destined to serve on horseback and act as his body-guard; this body of cavalry was called the *celeres*, and afterwards the *equites*. (Dionys., ii. 13.) Niebuhr supposes ('Hist. of Rome,') that whereas *patres* and *patricii* were titles of honour for individuals, *celeres* was the name of the whole class as distinguished from the rest of the nation. The three centuries of the *celeres* were called by the same names as the three tribes of the patricians, namely, Ramnes, Tities, and Luceres. Their tribunes are spoken of as a college of priests (Dionys., ii. 64), and it appears that the tribes of the patricians had also tribunes (Dionys., ii. 7). Moreover, when it is said that Tarquinius Priscus made three new centuries, which he added to the former three, and that the whole went under the name of the Sex Suffragia, or the six equestrian centuries, we cannot doubt that the alteration which he introduced was a constitutional and not merely a military one; that in fact the centuries which he formed were, like the original three, tribes of houses; that his innovation was nothing but an extension of the political division of the inhabitants of Rome under Romulus. (Niebuhr, "Hist. of Rome.") When Servius Tullius established the comitia of the centuries, he received the sex suffragia, which included all the patricians, into his first class; and to them he added twelve other equestrian centuries, made up of the richest of the plebeian order. (Niebuhr.) The ancient writers appear to have laboured under some great confusion with regard to this arrangement. Livy (i. 43) makes a proper distinction between the twelve equestrian centuries created by Servius and the six which existed before; but when he states (i. 36) that the cavalry in the reign of Tarquinius Priscus amounted to 1800, he appears to be antedating the origin of the eighteen equestrian centuries which formed part of the constitution of Servius. To the establishment of the comitia centuriata the creation of a body of equites, as a distinct order, seems to be due. The plan of Servius was, to a certain extent, identical with that of Solon. The object of both legislators was to break down the limits to which the old aristocracy was confined, and to set up an order of wealth by the side of the order of birth: not, however, that when a person could produce his 400,000 sesterces, he became *ipso facto* a knight, as was the case in after times. (Hor. "Ep." i. 1, 57.) According to the Servian constitution, good birth or the sanction of the censors was necessary for gaining a place in the equestrian order. (Polyb., vi. 20; Zonaras, vii. 19.) When Cicero says ("De Republica," ii. 20) that Tarquinius established the equestrian order on the same footing as that on which it stood in his own time, and also attributes to the same king the assigning of money to the equites for the purchase and keep of their horses, he is evidently inconsistent. In Tarquin's time, that is, before there was any plebeian order, it was natural enough that the poorer patricians, who were obliged to serve on horseback, just as the 'Ἱππῆς at Athens, who were a poorer class than the Pentakosiomedimnoi, (Plut., "Sol." c. 18.) should be furnished with the means for doing so. But the case was different with the equites after the establishment of an order of wealth. A man might then be of equestrian rank, and yet have no horse assigned to him; thus, on the one hand, we find at the time of the siege of Veii a number of equites serving on horseback at their own expense (Liv., v. 7); and, on the contrary, L. Tarquitius, who was a patrician, was obliged to serve on foot from his poverty. (Liv., iii. 27.) From this it appears probable that a certain sum was fixed which it was not necessary for every eques to have, but the possessor of which was obliged to serve on horseback at his own expense if no horse could be given him by the public, and that those whose fortune fell short of this were obliged to serve in the infantry under the same circumstances.

The lieutenant of the dictator was called "the chief of the equites" (*Magister Equitum*); and although in later times he was appointed to this office by the dictator himself, it is probable, as Niebuhr conjectures (i., p. 559), that he was originally elected by the twelve centuries of Plebeian equites just as the dictator, or *Magister Populi*, was by the *Sex Suffragia*, in other words, by the Populus or Patricians.

With regard to the functions of the equites, besides their military duties, they had to act as judices or jurymen under the Sempronian law: under the Servilian law the judices were chosen from the senate as well as from the equites: by the Glaucian law the equites alone performed the office, and so on by alternate changes till the law of Aurelius Cotta (B.C. 70), by which the judices were chosen from the senators, equites, and tribuni ærarii. The equites also farmed the public revenues. Those who were engaged in this business were called the *Publicani;* and though Cicero, who was himself of the equestrian order, speaks of these farmers as "the flower of the Roman equites, the ornament of the state, the safeguard of the republic" ('Pro Plancio,' 9), it appears that they were a set of detestable oppressors, who made themselves odious in all the provinces by their avarice and rapacity.

The equites, as it may be inferred from what has been already said, gradually lost the marks of their distinctive origin, and became, as they were in the time of Cicero for instance, an ordo or class of persons as distinguished from the senate and the plebs. They had particular seats assigned to them in the circus and the theatre. The insignia of their rank, in addition to the horse, were, a golden ring and the angustus clavus, or narrow band, on their dress, as distinguished from the latus clavus or broad band of the senators: the two last insignia seem to have remained after the former ceased to possess its original and distinctive character.

EQUITY, according to the definition given by Aristotle, is "the rectification of the law, when, by reason of its universality, it is deficient; for this is the reason that all things are not determined by law, because it is impossible that a law should be enacted concerning some things; so that there is need of a decree or decision; for of the indefinite the rule also is indefinite: as among Lesbian builders the rule is leaden, for the rule is altered to suit the figure of the stone, and is not fixed, and so is a decree or decision to suit the circumstances." (*Ethics*, B. v. c. 01, Oxford trans.) "Equity," says Blackstone, "in its true and genuine meaning, is the soul and spirit of all law; positive law is construed and rational law is made by it. In this respect, equity is synonymous with justice; in that, to the true and sound interpretation of the rule." According to Grotius, equity is the correction of that wherein the law, by reason of its generality, is deficient.

Until jurisprudence has become really a science based on settled principles, some such jurisdiction as our earlier law-writers have attributed to the courts of equity is necessary to the due administration of justice; and it is probable that in England it deserved the humorous description given by Selden in his 'Table Talk:' "Equity in law is the same that spirit is in religion, what every one pleases to make it; sometimes they go according to conscience, sometimes according to law, sometimes according to the rule of court. Equity is a roguish thing; for law we have a measure, know what to trust to; equity is according to the conscience of him that is chancellor, and as that is larger or narrower, so is equity. It is all one as if they should make the standard for the measure we call a foot a chancellor's foot; what an uncertain measure would this be! One chancellor has a long foot, another a short foot, a third an indifferent foot: it is the same thing in the chancellor's conscience."

This uncertainty has however long ceased in that branch of our law which is expressed by the term Equity, and, from successive decisions, rules as strict and principles as fixed have been framed and established in our courts of equity as in our courts of law. New cases, it is true, may and do arise, but they are decided upon these ascertained rules and principles, and not from the notions of the judge as to what may be reasonable or just in the particular case before him. Nothing in fact is more common than to hear the chancellor say, that whatever may be his own opinion, he is bound by the authorities, that is, by the decisions of his predecessors in office and those of the other judges in equity; that he will not shake any settled rule concerning property, &c., it being for the common good that these should be certain and known, however ill-founded the first resolution may have been.

In its enlarged sense, equity answers precisely to the definition of justice, or natural law (as it is called), as given in the 'Pandects' (lib. i. tit. 1, l, 10, 11); and it is remarkable that subsequent writers on this so-called natural law, and also the authors of modern treatises on the doctrine of equity, as administered in the English courts, have, with scarcely any exception, cited the above passage from Aristotle as a definition of equity in our peculiar sense of a separate jurisdiction. But according to this general definition every court is a court of equity, of which a familiar instance occurs in the construction of statutes, which the judges of the courts of common law constantly interpret according to the spirit, or, as it is called, the equity, not the strict letter.

It is hardly possible to define equity as now administered in this country, or to make it intelligible otherwise than by a minute enumeration of the matters cognisable in the courts in which it is administered in its restrained and qualified sense. "It is no longer," says Sir James Mackintosh in his life of Sir Thomas More, "in the acceptation in which the word is used in English jurisprudence, to be confounded with that moral equity which generally corrects the unjust operation of law, and with which it seems to have been synonymous in the days of Selden and Bacon. It is a part of laws formed from usages and determinations which sometimes differ from what is called common law in its subjects, but chiefly varies from it in its mode of proof, of trial, and of relief."

In this country the remedies for the redress of wrongs and for the enforcement of rights are distinguished into two classes, *those which are administered in courts of law*, and *those which are administered in courts of equity;* the former are called legal rights and wrongs, the latter equitable. Equity jurisdiction may therefore properly be defined as that portion of remedial justice which is administered by a court of equity as distinguished from a court of law, from which a court of equity differs mainly in the subject matters of which it takes cognizance and in its mode of procedure and remedies.

Courts of common law in this country proceed by certain prescribed forms of action alone, and give relief only according to the particular exigency of such actions, by a general and unqualified judgment for the plaintiff or the defendant. There are many cases, however, in which a simple judgment for either party, without qualifications or conditions, or peculiar arrangements, will not do entire justice. Some modifications of the rights of both parties may be required; some restraints on one side, or the other, or perhaps on both; some qualifications or conditions present or future, temporary or permanent, to be annexed to the exercise of rights, or the redress of injuries. To accomplish such objects the courts of law in this country have no machinery: according to their present constitution they can only adjudicate by a simple judgment between the parties. Such prescribed forms of actions are not confined to our own system of laws; they were known in the civil law, and the party could apply them only to their original purposes. In other cases he had a special remedy. Courts of equity, however, are not so restrained; they adjudicate by decree pronounced upon a statement of his case by the plaintiff, and the answer of the defendant given in upon *oath*, and the evidence of witnesses, together, if necessary, with the evidence of all parties, also given upon oath. These decrees are so adjusted as to meet all the exigencies of the particular case, and they vary, qualify, restrain, and model the remedy so as to suit it to mutual and adverse claims, and the real and substantial rights of all the parties so far as such rights are acknowledged by the established rules of equity.

The courts of equity bring before them *all* the parties interested in the subject matter of the suit, and adjust the rights of all however numerous; whereas courts of law in this country are compelled by their constitution to limit their inquiry to the litigating parties, although other persons may be interested: that is, they give a complete remedy in damages or otherwise for the particular wrong in question as between the parties to the action, though such remedy is obviously in many cases an incomplete adjudication upon the general rights of the parties to the action, and fails altgether as to other persons, not parties to the action, who yet may be interested in the result or in the subject matter in dispute.

Perhaps the most general as well as the most precise description of a court of equity is the outline given by Mr. Justice Story in the 'Encyclopædia Americana,' which he afterwards filled up in his well-known Treatise on Equity. It is this—that a court of equity has jurisdiction in cases where a plain, adequate, and complete remedy cannot be had in the common law courts. The remedy must be *plain*, for if it be doubtful and obscure at law, equity will assert a jurisdiction. It must be *adequate*, for if at law it fall short of what the party is entitled to, that founds a jurisdiction in equity; and it must be *complete*, that is, it must attain the full end and justice of the case, it must reach the whole mischief and secure the whole right of the party present and future, otherwise equity will interpose and give relief. The jurisdiction of a court of equity is sometimes concurrent with the jurisdiction of the courts of law; sometimes assistant to it; and sometimes exclusive. It exercises concurrent jurisdiction in cases where the rights are purely of a legal nature, but where other and more efficient aid is required than a court of law can afford. In some of these cases courts of law formerly refused all redress, but now will grant it. For strict law comprehending established rules, and the jurisdiction of equity being called into action when the purposes of justice rendered an exception to those rules necessary, successive exceptions on the same grounds became the foundation of a general principle, and could no longer be considered as a singular interposition. Thus law and equity are in continual progression, and the former is constantly gaining ground upon the latter. Every new and extraordinary interposition is by length of time converted into an old rule; a great part of what is now strict law was formerly considered as equity, and the equitable decisions of this age will unavoidably be ranked under the strict law of the next. (Prof. Millar's 'View of the English Government.') But the jurisdiction having been once justly acquired at a time when there was no such redress at law, it is not now relinquished by the courts of equity.

The most common exercise of the concurrent jurisdiction is in cases of account, accident, dower, fraud, mistake, partnership, and partition. In many cases which fall under these heads, and especially in some cases of fraud, mistake, and accident, courts of law cannot and do not afford any redress: in others they do, but not in so complete a manner as a court of equity.

A court of equity is also assistant to the jurisdiction of the courts of law in cases where the latter have no like authority. It will remove legal impediments to the fair decision of a question depending at law, as by restraining a party from improperly setting up, at a trial, some title or claim which would prevent the fair decision of the question in dispute; by compelling him to discover, upon his own oath, facts which are material to the right of the other party, but which a court of law cannot compel him to disclose; by perpetuating, that is, by taking and keeping in its custody, the testimony of witnesses, which is in danger of being lost before the matter can be tried; and by providing for the safety of property in dispute pending litigation. It will also counteract and control fraudulent judgments, by restraining the parties from insisting upon them.

The exclusive jurisdiction of a court of equity is chiefly exercised in cases of merely equitable rights, that is, such rights as are not recognised in courts of law. Most cases of trust and confidence fall under this head. This exclusive jurisdiction is exercised in granting injunctions to prevent waste or irreparable injury; to secure a settled right, or to prevent vexatious litigation; in appointing receivers of property which is in danger of being misapplied; in compelling the surrender of securities improperly obtained; in preventing a party from leaving the country in order to avoid a suit; in restraining any undue exercise of a legal right; in enforcing specific performance of contracts; in supplying the defective execution of instruments, and reforming, that is, correcting and altering them according to the real intention of the parties, when such intention can be satisfactorily proved; and in granting relief in cases where deeds and securities have been lost.

Much discussion has taken place and various opinions have been expressed upon the question whether it would or would not be best to administer the whole of remedial justice in one court or in one class of courts without any separation or distinction of suits, or of the forms or modes of procedure and relief. Lord Bacon, upon more than one occasion, has expressed his decided opinion that a separation of the administration of equity from that of the common law is wise and convenient. "All nations," says he, "have equity, but some have law and equity mixed in the same court, which is worse, and some have it distinguished in several courts, which is better;" and again, "In some states, that jurisdiction which decrees according to equity and moral right, and that which decrees according to strict right, is committed to the same court; in others, they are committed to different courts. We entirely opine for the separation of the courts; for the distinction of the cases will not long be attended to if the jurisdictions meet in the same person; and the will of the judges will then master the law."

Lord Hardwicke held the same opinion. Lord Mansfield, it is to be presumed, thought otherwise, for he endeavoured to introduce equitable doctrines into the courts of law. The old strictness has however been restored. His successor, Lord Kenyon, made use of these expressions: "If it had fallen to my lot to form a system of jurisprudence, whether or not I should have thought it advisable to establish different courts, with different jurisdictions, and governed by different rules, it is not necessary to say; but influenced as I am by certain prejudices that have become inveterate with those who comply with the systems they find established, I find that in these courts, proceeding by different rules, a certain combined system of jurisprudence has been framed most beneficial to the people of this country, and which I hope I may be indulged in supposing has never yet been equalled in any other country on earth. Our courts of law only consider legal rights; our courts of equity have other rules, by which they sometimes supersede strict legal rules, and in doing so they act most beneficially for the subject." In this country the principle of separating jurisdictions has been largely acted upon. We have our courts of equity and law; our bankrupt and insolvent courts, and courts of ecclesiastical and admiralty jurisdiction; indeed, until recent times, our several courts of law had, in principle, jurisdiction only over certain specified classes of suits. In countries governed by the civil law, the practice has in general been the other way. But whether the one opinion or the other be the more correct in theory, the system adopted by every nation has been mainly influenced by the peculiarities of its own institutions, habits, and circumstances, and the forms of its remedial justice. In all such cases the separation or union of the equitable and legal jurisdiction must be a mixed question of public policy and private convenience.

In some of the American States, the administration of law and equity is perfectly distinct; in others the administration of equity is only partially committed to distinct courts; in a third class the two jurisdictions are vested in one and the same tribunal; and in a fourth there are no courts exercising an equitable jurisdiction.

In most of our colonies the governor is invested with the jurisdiction of chancellor; but in some of the greatest importance where a judicial establishment of some magnitude is maintained, the chief or supreme court is invested with the chancery jurisdiction.

This attempt at the exposition of the general principles of what in this country is called equity seems to the writer of this article to be better suited to a work of this nature than a full description of the practice of, that is, the course of proceeding in, a suit in a court of equity. The practice or procedure of any court can hardly be made intelligible to any person but one who knows something of it by experience; and any technical description of it is useless unless it is minutely and circumstantially exact. It is desirable, however, that in addition to some knowledge of the subjects which belong to the jurisdiction of a court of equity, all persons should have some clear notion of the way in which the matters in dispute between parties to a suit in equity are brought before the court, and by what kind of proof or evidence they are established. It may also be useful that persons should have a general, and so far as it goes, a correct knowledge of the different modes in which such questions of fact are put in issue, and proved in our courts of law and equity. The following short outline of the course of proceeding in a suit of chancery, taken in connection with other articles in this work, such as Chancellor, Chancery, Deposition, and Pleading, may probably, so far as it goes, give somewhat more information on the subject of equity jurisdiction than is found in books not strictly professional.

A suit in the courts of chancery is commenced by presenting a petition to the lord chancellor, containing a statement of the plaintiff's case, and praying for such relief as he may consider himself entitled to receive. This petition is technically called a Bill, and is in the nature of the declaration at common law [Declaration]; but if the suit is instituted on behalf of the crown, or a charity, or any of the objects under the peculiar protection of the crown, the petition is in the form of a narrative of the facts by the attorney-general, and is called an Information. There is also a petition termed an Information and Bill, which is where the attorney-general, at the relation (that is, the information) of a third person (thence called the relator) informs the court of the facts which he thinks are a fit subject of inquiry. The practice which governs all these proceedings is the same. It used to be the practice at the end of the statement in a bill to add what was called the interrogating part, consisting of the statements of the bill thrown into the form of distinct questions, and often expressed in terms of great length and particularity. But by a recent enactment, a bill no longer contains interrogatories, which may, however, if thought requisite, be filed separately. The statements in the bill are not made upon oath; and further, in order to obtain a full and complete discovery from the defendant, both as regards the complaint and the supposed defence, various allegations are made in many cases from mere conjecture, and this practice, it has been considered after much laboured discussion, tends to the due administration of justice; for though doubtless many frivolous suits are instituted, yet, from the nature of cases of fraud and concealment, the plaintiff is often ignorant of the precise nature of the case, and frames his bill in various forms so as to elicit from the defendant a full discovery of the truth. Bills of this nature are called original bills, and either may be for discovery and relief, or for discovery merely.

When the bill is placed on the records of the court it is said to be *filed*, and the writ of subpœna issues commanding the defendant to appear and answer the allegations of the bill within a certain time.

If, upon the face of the bill, it should appear that the plaintiff is not entitled to the relief prayed for as against the defendant, the defendant may demur,—that is, demand the judgment of the court upon the statement made by the plaintiff, whether the suit shall proceed [Demurrer]; and if any cause, not apparent upon the bill, should exist why the suit should be either dismissed, delayed, or barred, the defendant may put in a plea, stating such matter, and demanding the judgment of the court, as in the case of a demurrer. But if neither of these modes of defence are applicable, and the defendant cannot disclaim [Disclaimer], he must answer upon oath the interrogatories in the bill according to the best of his *knowledge, remembrance, information*, and *belief*. This mode of defence is styled an Answer. All or any of these several modes of defence may be used together, if applied to separate and distinct parts of the case made by the plaintiff.

In the successive stages of a suit, references as to the pleadings, and as to facts, may be made to the judges in equity sitting at chambers, who conduct the routine part of the business through their chief clerks. These references were formerly made to the Masters of the court. If the defendant does not answer the bill with sufficient precision, the plaintiff may except to the answer for insufficiency. If the answer is decided to be insufficient, the defendant must answer further.

It frequently happens that, during the progress of the suit, from the discovery of new matter, the deaths and marriages of parties, and other causes, the pleadings become defective, and in these cases it is necessary to bring the new matter, or parties becoming interested, before the court. This is done by means of further statements, which are now introduced by way of amendments to the bill, or by obtaining leave of the court to revive a suit which has abated, proceedings which recent legislation has rendered very simple and rapid. Formerly the same thing was done by fresh bills, called supplemental bills, bills of revivor, or bills of revivor and supplement, according to the nature of the defect which they were intended to supply.

Pleas and demurrers are at once argued before the court: if allowed, the suit, or so much of it as is covered by the demurrer or plea, is at an end, though the court will generally permit the plaintiff to amend his bill where it is not apparent from his own statement that he cannot make any case against the defendant; otherwise the only object attained by the demurrer or plea would be to drive the plaintiff to file a new bill, omitting or amending the objectionable part. But if the demurrer or plea is overruled, the defendant is compelled to answer fully, just as if he had not demurred or pleaded. When the answer is filed, the plaintiff, if from the disclosures made he deems it advisable, may amend his bill; that is, erase such part of his statements as he no longer considers necessary, and insert other statements which may appear necessary to sustain his case; and the defendant must answer to this new matter.

In cases where the bill is for discovery only, and in some others, the answer puts an end to the suit; and when the object of the bill is to obtain an injunction, which is granted either upon affidavits before answer or in default of an answer, the suit is also ended, unless the defendant desires to dissolve the injunction. But where a decree is necessary, the case must come on to be heard either upon evidence taken before the examiners of the court or commissioners appointed for the purpose [Deposition]; or where the plaintiff considers the disclosures in the answer sufficient, the cause is heard upon bill and answer alone, without further evidence, and this is at the plaintiff's discretion.

The cause is heard in its turn by the master of the rolls or the vice-chancellors, if instituted in the Court of Chancery; for the lord chancellor rarely hears causes in the first instance. [Chancery.] If the nature of the suit admits, a final decree is made; or if any further inquiry be necessary, or any accounts are to be taken, references are made to the judge sitting at chambers for those purposes.

This is the form of the simplest suit by bill in equity, and is sufficient to point out the successive steps necessary to be taken. For certain cases of a simple kind a still more brief proceeding, called a claim, has recently been introduced. Formerly suits were of a far more complicated character. Many special applications to the court might become necessary at various stages before the cause was ripe for hearing; and the references made to the masters, their reports thereon, hearing on further directions, and fresh references, used frequently to consume much time. Under the present state of things, these matters are settled in a much more prompt way, and most successful efforts have been made to simplify and shorten procedure. The recent statute 15 & 16 Vict. c. 86, and some others, have so altered the practice that the old text-books have been nearly superseded. Those who wish for a more accurate knowledge of the proceedings in a suit in chancery may consult Daniell's 'Chancery Practice,' third edition.

The principal English treatises on equity are those of Mr. Maddock and Mr. Fonblanque: the former treats of his subject under heads devoted to the several subject matters cognisable in courts of equity; the latter considers it with reference to the jurisdiction exercised by courts of law, as concurrent, assistant, exclusive. The American treatise of Mr. Justice Story unites these two modes, and explains the subject in a masterly and scientific manner.

EQUITY OF REDEMPTION. [Mortgage.]

EQUIVALENT NUMBER. [Chemical Equivalents.]

EQUU'LEUS (the Little Horse), a constellation of Ptolemy, surrounded by Pegasus, Vulpecula, Aquila, and Capricornus.

The following are the principal stars.

Character.	No. in Catalogue of Flamsteed.	No. in Catalogue of British Association.	Magnitude.
γ	5	7350	4
δ	7	7372	4
α	8	7380	4
β	10		4

EQUU'LEUS PICTO'RIS (the Painter's Horse, or Easel), a constellation of Lacaille, situated close to the principal star of Argo. [Canopus.] Its principal star (α) is 583 of Lacaille, and 2260 in the Catalogue of the British Association.

ERA. [Æra.]

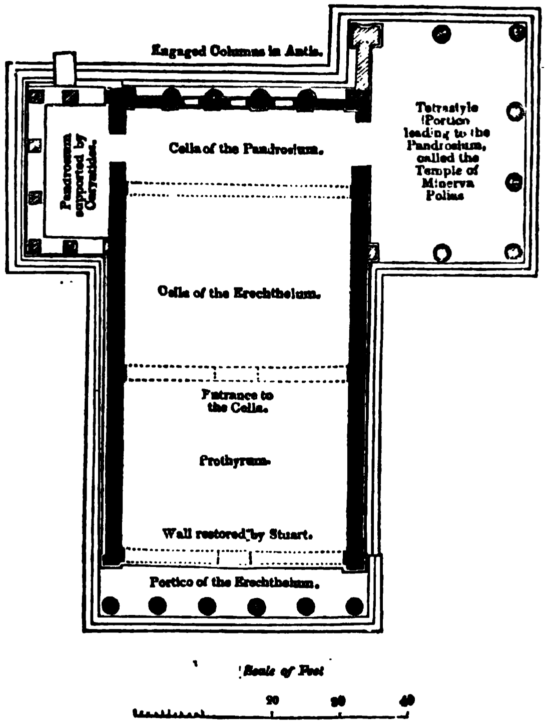
ERASTIANISM. [Erastus, in Biog. Div.]

ERATO. [Muses.]

ERBIUM; (Er.) a metal discovered by Mosander associated with yttria. Its properties are but little known. Some of them are as follows:—Its oxide becomes of a dark orange colour when heated in contact with the air, which colour it loses with a little weight, when heated in hydrogen gas. It is to the presence of this oxide that yttria owes its yellow colour, when prepared as hitherto directed. The sulphate and nitrate of erbium are free from colour. It has not been reduced to the metallic state.

ERECHTHEIUM, a beautiful Ionic temple dedicated to Erechtheus, built near the western brow of the Acropolis at Athens, and at the time when Stuart visited the place forming part of the modern fortress of the Acropolis. Connected with this building, and placed on one side of it at the end of the cella, is a tetrastyle pseudo-dipteral Ionic portico, in the same style as the portico of the Erechtheium: and on the opposite side is a small roofed building supported by caryatides, placed on an elevated basement. [Caryatides.] The Erechtheium was thus, as Mr. Fergusson remarks, properly three temples grouped together, the whole presenting a singularly picturesque group of the most studied irregularity, though the separate features are as studiously symmetrical. The back wall of the cella of the Temple of Erechtheus is decorated with four semi-columns in antis engaged in the wall, and of the same order as the portico, which is hexastyle, and raised on three steps, forming a basement which runs round the entire building with its adjuncts. In Stuart's 'Athens,' the prothyrum is restored, and forms a closed chamber, for which there does not appear to be sufficient authority. It is more probable that the prothyrum was open, like some other Greek temples, because, as shown on Stuart's plan, the portico from its shallowness would be of little use as a covering, and would also produce little architectural effect. In the side portico, called Minerva Polias, which was most probably constructed after the Erechtheium, there was no opportunity of producing a depth of shadow by the deep recess of an open prothyrum, and the architect accordingly appears to have adopted the pseudo-dipteral portico to produce a somewhat similar effect, as well as to gain a covered space for those who officiated. It would appear from the regularity of the plan of the Temple of Erechtheus, that it was constructed before the other, and of that regular parallelopipedal figure most commonly employed in these buildings; and that at a later period the Pandrosium was constructed, with the portico on the opposite side forming the entrance or vestibule to the cella of the temple, which was formed from a part of the cella of the Temple of Erechtheus, cut off from the end of that cella, which was either at that time or previously lighted with windows.

The length of the Temple of Erechtheus is 73 feet 2 inches from the columns of the portico to those at the back of the cella; the width is 36 feet 6 inches. The depth of the portico of Minerva Polias is 21 feet 1 inch, and the width 33 feet 1 inch. The Pandrosium is 18 feet 4 inches wide, and 11 feet 9 inches deep. (Stuart's 'Antiquities of Athens,' edited by W. Kinnard, architect.) The columns of the Erechtheium are 2 feet 3·8 inches in diameter at the base, and 1 foot 11·2 inches at the upper diameter; and those of the Minerva Polias 2 feet 6·9 inches, and the upper 2 feet 3·5 inches: while the intercolumniations are respectively—Erechtheium 4 feet 7·95 inches, Minerva Polias 7 feet, 8·19 inches, although there is a slight variation in the intercolumns, which may be the effect of time and inaccuracy in setting them out originally. The columns of the Minerva Polias are on a much lower level than those of the Erechtheium. The capitals of the order of these two temples are very richly carved. The volutes are very graceful [Column], and the spiral lines are elaborately arranged. The necking of the capital is enriched with leaves, as well as with an enriched ovolo and astragals, and the volutes are connected by an enriched twisted band or guilloche ornament. The shafts are fluted. But with regard to many peculiarities in the detail, we must refer to the plates in Stuart's 'Athens.' The entablatures have several of their members enriched, and are similar in design; the bases of the columns however vary. The height of the columns of the Erechtheium is 27 feet 7 inches, and of the Minerva Polias 25 feet. The pilaster of the Erechtheium is elegantly decorated, and the mouldings and decora-


Engaged Columns in Antis.
Pandrosium supported by Caryatides.
Cella of the Pandrosium.
Tetrastyle Portico leading to the Pandrosium, called the Temple of Minerva Polias
Cella of the Erechtheium.
Entrance to the Cella.
Prothyrum.
Wall restored by Stuart.
Portico of the Erechtheium.
Scale of Feet
20
30
40

[Plan of the Erechtheium.]

tions are continued under the architraves. The height of the entablature of the Erechtheium is 4 feet 11 inches; and the height of the Minerva Polias is 5 feet 5 inches. The rise in the pediment of the portico of the latter is 3 feet 4 inches. The entablature of the Pandrosium is heavy; it is decorated with dentils, and also with pateræ on the upper face of the architrave. The windows and doors diminish at the top, and the friezes of the porticos appear to have been formerly decorated, if we may judge from the remains of cramps and cramp-holes on their faces. Some details respecting this building, not published in Stuart, are given in the 'Erechtheion,' a work on this edifice by H. W. Inwood, architect, who has imitated the Erechtheium and Pandrosium in the external design of part of St. Pancras Church, London. Stuart's 'Athens,' vol. ii., contains the plans, elevations, sections, and details of this building.

EREMACAUSIS. *Decay.* Eremacausis literally signifies slow burning; that is, gradual oxidation.

In popular language, the word decay is expressive of the constant retrogressive change of which matter is susceptible. The crumbling walls of an old ruin, the few hollow trunks in its vicinity, and the traces of life that once animated the scene, are familiar examples of a state of things that is somewhat loosely expressed by the term decay. A dead animal, under ordinary circumstances, soon commences to alter in colour, noxious odours are emitted from it, and an appeal is made to the eyes and nose of the observer sufficient to indicate that a considerable change from the normal condition of the animal is taking place. This change is generally denoted by the word decay, and consists in the gradual wasting or burning away of the animal by the *chemical* action of the oxygen of the air; by which all parts of it, except bones, are slowly and almost entirely resolved into gaseous compounds. Old walls crumble away, not by true decay, not by the chemical action of the oxygen of the air, but principally by the *mechanical* action of wind and rain.

In order therefore to avoid much ambiguity, it has long been the practice in scientific treatises, and is now becoming the general custom, to indicate decay proper by the term eremacausis. This term has also the advantage of perfectly describing what is known to take place.

Eremacausis, fermentation, and combustion, are phenomena that are frequently very intimately associated; but no difficulty will be found in assigning to each its proper limits, if it be remembered, first, that fermentation is simply a rearrangement of the constituents of a compound; second, that eremacausis is a slow oxidation of the compound at common temperatures; and third, that combustion is rapid oxidation of a compound at a temperature sufficiently high to produce light. [COMBUSTION; FERMENT.]

The natural processes of fermentation and eremacausis may be not inaptly compared with the artificial processes of dry distillation and combustion. In the manufacture of gas, for example, coal is heated in closed vessels (that is, it is submitted to dry distillation), when a rearrangement of the constituents of the coal takes place, and coal-gas, coal-tar, coke, &c., result. When, however, coal is burned in a common stove, then the same kind of change is produced as occurs in eremacausis, namely, a combination of the constituents of the coal with the oxygen of the air, but the process goes on at a sufficiently rapid rate and at a sufficiently high temperature to produce light, and is therefore denominated combustion.

Eremacausis is almost entirely confined to the animal and vegetable kingdoms. Few minerals are acted upon by the oxygen of the air, and even when this action does take place the change is never a retrogressive one. Iron pyrites, for example, a compound of sulphur and iron (FeS_2), undergoes slow oxidation on exposure to air, but the resulting compound, sulphate of iron (FeO,SO_3), is more complex than the pyrites.

Animals and vegetables grow or are built up by virtue of certain influences which are sometimes aggregated under the name *vital force;* and when these influences cease, not only does the progressive action terminate, but eremacausis commences, especially if air and moisture are present. Organised bodies are composed of matters called proximate principles. Such are, in vegetables, starch, cellulose, gluten, sugar, &c., while in animals some of these principles form fat, others blood, &c. These proximate principles are again composed of other substances, called ultimate principles or elements. The elements necessary to notice here, are carbon, oxygen, hydrogen, and nitrogen. Organised bodies get these elements from the inorganic world, that is, from the earth and atmosphere. Vegetables get carbon from carbonic acid (CO_2), a gas, composed of carbon and oxygen, and always present in the air; hydrogen and oxygen they chiefly obtain from water, and nitrogen from various sources, though the ultimate but indirect source is, no doubt, the atmosphere, of which four-fifths are nitrogen. In addition to these elements, vegetables contain bone-forming material (phosphate of lime, &c.), which they have obtained by their roots directly from the earth, and which material, after having performed its office of building up the animal skeleton, is again returned to the earth without going through re-composition, or decomposition. Some animals derive the elements enumerated, by feeding upon vegetables; whilst others derive these principles more directly by feeding upon animals. Thus are animal and vegetable organisms built up, but at every step the combination of forces above alluded to, is essential, and its action consists chiefly in the production of complex compounds from more simple ones; hence it might be expected that the elements composing these complex compounds having been, so to speak, drawn out of their first and most stable condition, should have a tendency to return to that state in which the forces that operated upon them are either removed or altered in direction. Such is indeed the case, and this retrogressive change, or eremacausis, soon commences after the cessation of life, and goes on at, according to circumstances, a slow or rapid rate. In illustration of eremacausis let us follow the element carbon through one or two of its circles of usefulness. Thrown into the atmosphere, from the combustion of coal or wood, under the form of carbonic, acid, it is absorbed and assimilated by plants, the oxygen of the carbonic acid being returned to the air. The leaves of the plant will probably die when winter comes, and then will either undergo thorough or partial eremacausis, the carbon being either slowly but completely burnt into carbonic acid and returned into the atmosphere, or partially oxidised and converted into humus, or vegetable mould.

Other parts of the plant are perhaps eaten by man or the lower animals, and their carbon thus becomes part of an animal body, there to do duty until chemical affinity, under the form of eremacausis, once more restores the carbon to the air as carbonic acid, only to pass again through the same cycle of changes.

The three remaining chief elements of organised bodies are also affected by eremacausis, the hydrogen being converted into water, and the nitrogen, either into nitric acid or ammonia, while the oxygen escapes either as water or carbonic acid.

Eremacausis appears essentially to precede and determine the processes of fermentation and putrefaction, and hence, if organic substances be rigidly excluded from contact with oxygen, they cannot be subject to either of these processes; since eremacausis can only occur in the presence of free oxygen. Advantage is taken of this fact to preserve meat and vegetables in all their original freshness, by enclosing them in air-tight canisters, from which atmospheric air has been carefully expelled. If the smallest trace of air be suffered to remain in the canisters or in the pores of the enclosed substances, eremacausis commences, and determines putrefaction, which latter process, once commenced, is scarcely retarded by exclusion of air, and thus it is that meats carelessly preserved are found, on opening the cases, to be utterly putrid. [FERMENT; PUTREFACTION.]

ERGOT, *Medical Uses of.* Ergot is a name bestowed upon a peculiar state of the seed of several cereal grains, but most frequently of the rye, which resembles a spur, or horn; hence, likewise, termed *Secale cornutum*, or *spurred* rye. Even the common rye-grass is liable to its attacks, and more rarely some cyperaceous plants. A partial list of these is given in the papers of Smith, Quekett, and Bauer, in 'Trans. of Linnæan Society,' vol. xviii. pp. 449–482, and a more complete one by Phoebus (Deutschl. Kryptogam. Giftegewächse. Berlin, 1838). Whether this state of the grain be merely an altered condition of the pistil, or the result of the puncture of insects, or of the development of a fungus, is doubtful; but the best authorities incline to the opinion that it is a fungus. (See Mr. Bauer's paper on the *Uredo fœtida* 'Supplement to the Penny Magazine,' March, 1833.) De Candolle considers the fungus to be the *Sclerotium clavus*. It is termed *Spermœdia clavus* by Fries; *Sphacelia Segetum* by Lévillé; *Ergotætia abortifaciens* by Quekett; *Hymenula clavus* by Corda; and, lastly, *Oidium abortifaciens* (see Lindley, 'Medical and Œconomical Botany,' p. 14), by Berkeley, who considers it analogous to the parasitic fungus so destructive to the vines. The spur is of variable length, from a few lines to two inches, and is from two to four lines in thickness; when large, only a few grains in each ear are affected; when small, in general all of them are diseased. In colour the exterior or husk is of a bluish-black or violet hue, with two or three streaks of dotted gray; the interior is of a dull whitish or gray tint. It is specifically lighter than water, which affords a criterion for distinguishing sound from tainted grain. When fresh it is tough and flexible, but brittle and easily pulverised when dry. The powder is apt to attract moisture, which impairs its properties. Time also completely dissipates its peculiar qualities. A small *Acarus* attacks it. It is more potent in proportion to its freshness. "It has a disagreeable heavy smell (which being analogous to that of many fungi, strengthens the opinion that it belongs to that class of vegetable substances), a nauseous, slightly acrid taste, and imparts both its taste and smell to water and alcohol. Bread which contains it is defective in firmness, liable to become moist, and cracks and crumbles soon after being taken from the oven." [ERGOTIN.]

Bread prepared from grain which has a large admixture of the spur occasions very distressing and often fatal effects, which are shown more or less rapidly according to the quantity present in the food, and the circumstances in which those who use it are placed. These effects have been observed to be most serious in seasons of scarcity, when they produce dreadful disease—the *Raphanes* of Linnæus, Cullen, and other nosologists. The symptoms which result from spurred grain, when used for a considerable time, are of two distinct kinds, one of a nervous nature, characterised by violent spasmodic convulsions, the other a disordered state of the constitution, which terminates in the peculiar disease called Gangræna ustilaginea, or dry gangrene. A single dose of the spur, not diluted by admixture with sour flour, excites effects which vary according to the quantity taken and the state of the person, and are chiefly limited to the stomach and intestinal canal, if the dose be small; but if so much as two drachms be taken, it causes giddiness, headache, flushed face, pain and spasms in the stomach, nausea and vomiting, with colic, purging, and a sense of weariness and weight in the limbs. In the case of parturient females, when given at a certain stage of the labour, it is admitted by most practitioners and writers to produce specific effects, and to expedite the labour in a very marked manner. It is by some persons alleged to produce hurtful effects upon the child; but such consequences probably occur only when it has been used at an improper stage of the labour; or when it ought not to have been employed under any circumstances. The rules for its employment are given in works devoted to obstetrics, to which we refer. It has likewise been recommended in menorrhagia and in leucorrhœa, against the former of which it is most useful when dependent on debility.

The extraordinary effects of the ergot of rye have made it the subject of experiments in medicine. It has consequently become an article of commerce as a drug, and imported from the Continent. By an attentive observation of the circumstances which favour this disease in the rye, it might be profitable to cultivate the plant expressly for the ergot it produces. The seed which grows on the same ear with the ergot might be selected for seed, and a cold wet soil, with an ungenial aspect, might be chosen as most likely to perpetuate the disease, or steeping the most healthy seeds in water in which the sporidia of the *oidium abortifaciens* are contained, will, when planted, propagate the diseased form of the grain. The ergot is sold by druggists at from 10*s.* to 20*s.* per ounce, so that, if only a pound of ergot could be collected, it would be worth more than the produce in sound grain of an acre of the best land. At all events, it will well repay the trouble of picking out the ergot from the rye, where it is infected, and it is easily discovered, before reaping, from its prominence and black colour.

The nervous symptoms arising from the use of bread formed of spurred rye, may in general be cured by emetics, laxatives, and frequent small doses of opium, provided this treatment be adopted in reasonable time, and the unwholesome food completely withdrawn.

The tendency to dry gangrene is to be combatted by the use of cinchona and cordials, with local applications to the part threatened. The noxious food must be completely relinquished. (Christison 'On Poisons.')

This diseased condition of the seeds of certain grasses is also a matter of very great agricultural importance; its prevalence being the probable cause of much of the abortion of which dairy herds are sometimes the subject. A writer in the 'Agricultural Gazette' thus refers to the matter:—"In the western climate of this kingdom, the existence of this disease in the grasses of our pastures is by no means uncommon in the autumn of the year. An examination of the seed stems of our meadows will generally give evidence of the disease, but it is only when it is abundant that its influence is so manifest. Unfortunately much of the grass land in the moist climate of the west is too frequently the cause of trouble and loss by causing the abortion of the cows fed thereon. The disease is seldom found upon grass land which has been mown in the same season, and even when it is found its occurrence is so casual as to be of little importance. The land which has been grazed during the summer is that upon which the ergotised grass is found to exist most abundantly, because the stock having avoided the seed stems, these have been enabled to fulfil their special functions and produce seed which has subsequently become diseased. It is clear that if prevention is the object to be aimed at, this will be best attained by keeping breeding stock from land thus bearing a diseased produce. This may be accomplished on the majority of farms by removing the breeding cows and heifers from their summer pasturage, say in July, and keeping them afterwards upon land which had been mown that season. The removal of the stock should not be delayed until any case of abortion has positively occurred, because, that having once commenced it rapidly spreads through any herd, and often in opposition to every care. As soon as there is seed formed upon the seed-stems of the grass, the prudent breeder may take notice of danger, and his wisest policy will undoubtedly be to put his cows and heifers upon the after-grass. There are very many districts where the climate, from being dry, does not render this precaution necessary, but at the same time there are numerous tracts of land where the moisture of the climate acts upon the grass seeds, and favours the growth of ergotised grass, and such land is noted for the difficulty experienced in keeping the stock in proper breeding order. The age of the fœtus appears to be a matter of small importance, for it varies from two months upwards at the time when the abortion takes place. Some stock are much more sensitive to influences of this kind than others, and this is doubtless dependant upon their health and vigour; and thus stock which are well bred, *i.e.*, nearly related, are more liable to injury in this way than those which are inferior in this respect: for although by judicious breeding we improve the general character of an animal, yet at the same time this altered character is generally accompanied by diminished vigour.

"This explains how the best bred cows and heifers will often throw their calves, whilst some common stock about which the breeder is indifferent will frequently escape, although their treatment and food may be similar, and each may have partaken of this ergotised grass. Knowing as we do the action of this diseased form of grass seed, it becomes highly important that we should in this way avoid a cause so prolific of trouble and loss to many of our best breeders."

ERGOTIN is an active principle contained in ergot. [ERGOT, NAT. HIST. DIV.] It may be prepared by the following process, advantage being taken of its insolubility in water or ether and its solubility in alcohol. Powdered ergot is first thoroughly exhausted with ether by percolation, to get rid of fatty matter; it is then digested in boiling alcohol, filtered, the filtrate evaporated to the consistence of an extract, and the extract treated with water, which leaves the ergotin undissolved.

Ergotin has an acrid bitter taste, and, when warmed, a peculiar, unpleasant odour. It is soluble in caustic alkalies from which it is precipitated unchanged on addition of dilute acids. Strong sulphuric and acetic acids also dissolve it, dilution with water causing it to be again thrown down. It is infusible, and in contact with the air burns with a peculiar odour. Nitric acid decomposes ergotin.

Under the name of *Bonjean's Ergotin*, there occurs in pharmacy a preparation obtained by digesting the aqueous extract in alcohol and evaporating the solution to a proper consistence. As ergotin, properly so called, is in the pure state insoluble in water, it follows that Bonjean's preparation must owe its activity either to some other substance than ergotin, or that in the process for obtaining the aqueous extract, the ergotin is rendered soluble in water by the presence of other bodies in the ergot.

Ergotin is a poison, slow but deadly.

ERI'DANUS (the river Eridanus), a constellation first mentioned by Aratus, who calls it Eridanus. Hyginus states it to have been from the Nile, and assigns a reason [CANOPUS]; but the scholiast on Aratus states this to have been peculiar to the Egyptians. In the heavens it is a winding stream, not very well marked by stars, extending from a bright star (α) of the first magnitude, called Achernes, and situated near the southern part of Phœnix, past the feet of Cetus, and ending at the star Rigel in Orion. Its principal stars are as follows:—

Character.	No. in Catalogue of Flamsteed, Lacaille, C.	No. in Catalogue of British Association.	Magnitude.
τ^1	1	856	4
τ^2	2	887	4
η	3	910	3
τ^3	11	954	4
α	12	997	3·5
ζ	13	1013	4
τ^4	16	1037	3·5
..	17	1090	4
ϵ	18	1100	3·5
τ^5	19	1104	4
δ	23	1143	3·5
τ^6	27	1181	4
..	32	1216	4
τ^8	33	1217	4
γ	34	1284	2·5
o^1	38	1290	4·5
υ^4	41	1333	3·5
ν	48	1429	4
υ^2	52	1433	3·5
..	53	1441	4
μ	57	1469	4
λ	69	1597	4
α	484 C	507	1
χ	575 C	596	4
ϕ	693 C	717	4

ERIOMETER, an instrument invented by Dr. Thomas Young, for measuring the diameter of minute fibres, such as those of wool, whence the name (from ἔριον, wool, and μέτρον, a measure).

If we gently breathe upon a plate of glass, or scatter some very fine powder upon it, such as *Lycopodium* dust, and look through it at the sun or a candle, a number of rings of colour will be seen. There will be first round the luminous source a light area, terminating in a reddish dark margin; then a ring of bluish green, succeeded by a red ring, and these two last colours will be repeated several times if the particles are uniform in diameter. The effect is something like that produced by a halo round the sun or moon. As the diameter of the rings varies with the size of the particles, or fibres, it occurred to Dr. Young that the diameters of these minute bodies might be measured by determining the size of the rings produced by them. His eriometer consisted of a piece of card or a plate of brass with a hole about $\frac{1}{30}$th of an inch in diameter in the centre of a circle about half an inch in diameter, the circumference of which was perforated with eight or ten holes made as minute as possible. The fibres or particles to be measured are fixed in a slider, and the instrument being placed before a strong light, the observer, assisted by a lens behind the small hole, will see the rings. The slider must be drawn out until the limit of the first green ring and the red one coincides with the circle of perforations, and the index will then show on the scale the magnitude of the particles or fibres. The unit on this scale is that of the seed of the *Lycoperdon bovista*, which was ascertained by Dr. Wollaston to be

$\frac{1}{8500}$th of an inch in diameter, and as this substance gave rings which indicated 3½ on the scale, it follows that 1 on the same scale is equal to the 29,750th of an inch, or in round numbers the 30,000th part. In order therefore to convert the following measurements, which are selected from Dr. Young's copious table, into parts of an English inch, we have only to multiply $\frac{1}{30000}$ by the number in the table which expresses the diameter. Thus blood, diluted with water and placed between two pieces of glass, exhibits the rings very finely; this gives the number 6 or 7; accordingly we have the diameter of its particles thus: $\frac{1}{30000} \times 7 = \frac{7}{30000}$ or $\frac{1}{4285}$th part of an inch.

Milk diluted (the rings indistinct)	3
Dust of *Lycoperdon bovista* (rings very distinct)	3·5
Bullock's blood, from beef	4·5
Smut of barley	6·5
Blood of a mouse	6·5
Human blood diluted with water	5
„ „ after standing some days . 6 or	7
Pus	7·5
Silk	12
Beaver's wool	13
Mole's fur	16
Shawl wool	19
Saxon wool	22
Alpaca wool	26
Farina of *Laurustinus*	26
Merino, South Down	28
Seed of *Lycopodium* (the rings beautifully distinct)	32
Southdown ewe	39
Coarse wool	46
„ from worsted	60

By observing the fibres which compose the crystalline lenses of the eyes of fishes, Brewster was enabled to obtain some remarkable results as to their structure. They are noticed in his 'Treatise on Optics,' p. 114. [DIFFRACTION.]

ERMINE, or **ERMIN**, one of the furs in heraldry, so called from the *Mustela erminea*, whose skin furnishes it. It is represented white, with black spots or tufts. The black spots in ermine are not of any determinate number, but are left to the discretion of the herald-painter.

EROS (Ἔρως), of the Greek mythology, Cupid or Amor of the Latin, was the god of love. The Eros of the early Greeks was a very different deity to the sportive god of the later mythology, or the Cupid of the Romans. The first mention of Eros occurs in the Theogony of Hesiod, where he is spoken of as one of the first among the gods in order of time, the ruler of the minds of gods and men. In the Symposium of Plato, in the Orphic Hymns, and elsewhere, he is also called the eldest of the gods; the idea in all being, that love the uniter was one of the primary causes of the existence of all living things.

Sometimes this Eros of the early cosmogony is spoken of as self-created or born without parentage. The later Eros is always regarded as the son of Aphrodite, but his father is variously said to be Hermes, Ares, or even Zeus. Hence there were enumerated both by Greek and Roman writers three deities, or rather three forms of the same deity, bearing the name of Eros or Cupid. The Eros of the amatory poets, the one usually meant when the name Eros or Cupid occurs without qualification, is the son of Hermes and Aphrodite (the Mercury and Venus of the Romans). The earlier Eros was represented as a young man of youthful mien; and even in later times the statues of the god in temples presented the appearance of a boy of graceful well developed form, and tender expression. The wanton and wilful child, delighting in cruel sport and wild mischief, belongs to a phase in art corresponding to that of the erotic poetry in literature.

The Eros of the later Greeks, and of the Romans, is still the god of love, but it is love in its merely sensuous form. Yet even when the original conception had become most degraded, something of the nobleness and purity of the old idea was preserved in the beautiful myth of Psyche [PSYCHE]; and in Anteros, the opposing dæmon, the avenger of neglected love, who is so frequently associated with Eros, there appears to be a reference to the old idea of the sanctity of love.

In extant works of art, Eros is frequently represented as a slender, winged youth bending his bow. This is the position in which he appeared in the famous bronze statue of Praxiteles described by Callistratus, and which was regarded as one of the great sculptor's finest works. There are two statues of this kind in the British Museum, and several in other collections, which are considered to be repetitions or imitations of the statue of Praxiteles. By later artists he was represented as a boy breaking the thunderbolts of Zeus, or the insignia of the other gods; riding on a lion, or playing with and subduing other wild animals, typifying in all the resistless power of love. Sometimes he appears with Psyche as a beautiful girl; sometimes with her as a butterfly. Sometimes he accompanies Aphrodite; at others he appears attended by Anteros. The later sculptors and vase painters, and generally the artists of the Roman period, represented him in accordance with the descriptions of the amatory poets, as a winged child armed with bow and arrows, as an emblem of the inspiration of love, through the eye, from a distant object. Eventually they figured an unlimited number of Erotes,—always children and almost always winged—playing about in every variety of attitude, in the air and on the water, as well as on land; attending Aphrodite; sporting with dolphins; binding lions; sporting with tame, or driving wild, animals; gathering fruit; disguised as torch-bearers at weddings; as captives, encaged, or hiding in nests—and, in short, in every way which an unrestrained fancy could invent, when the religious idea had become entirely dissociated from the deity. Athenæus (xiii. 2) quotes a beautiful passage from the Phædrus of Alexis, to show the impossibility of representing Eros to the senses.

Eros. From British Museum.

Thespiæ, on the eastern slope of Mount Helicon, was the chief seat of the worship of Eros. The ancient symbol of the god was a rude stone; but afterwards Praxiteles' famous statue of Eros was placed here, and attracted to Thespiæ nearly as many strangers as his statue of Aphrodite attracted to Cnidus. A broken stone inscribed with the name of Praxiteles is said to be still remaining among the ruins at Thespiæ. It was at Thespiæ that the Erotidia, or games in honour of Eros, were celebrated every fifth year. Nothing is known of the Erotidia except that they were celebrated with great solemnity; that music and various athletic games were performed; and that large numbers of strangers flocked to Thespiæ in order to be present at them. At Athens the altar of Eros stood at the entrance to the Academy.

ERRHINES (from *en* (ἐν), and *rhin* (ῥιν), 'the nose'), medicines which are applied to the nostrils, and which cause an increased flow of the secretion of the membrane which lines them, and often of the contiguous cavities and sinuses; frequently also occasioning sneezing, and an unusual secretion of tears. Snuffs of different kinds are familiar examples of this class of substances, and these generally cause sneezing, at least when first employed; but others, such as the turpeth mineral, merely produce increased secretion of the membrane. Where sneezing ensues, a considerable shock is felt over the whole frame, and of this effect advantage is sometimes taken to change the action of the system, or to remove morbid impressions, as when certain fits are impending, or for more limited purposes, such as dislodging any foreign body from the nose. The secondary effect of errhines is more frequently desired to give relief to the loaded vessels, by exciting them to increased secretion. Hence they are used in various diseased conditions of the organ of smell, and even of the neighbouring organs, being supposed to influence the vessels of the eye, and even of the brain. Some affections of the eye, and also of the head, are certainly relieved by such means, and their occasional use may be permitted; but the habitual use of errhines is in most cases objectionable, and followed by hurtful consequences. The membrane of the nose becomes thickened, its sensibility impaired, and the power of discriminating odours greatly lessened; while, if the substance be possessed at the same time of narcotic qualities, such as snuff procured from tobacco, the palate, the stomach, and other organs concerned in digestion likewise suffer, and loss of appetite with other symptoms of indigestion result. [STERNUTORIES.]

ERROR (in Law), a fault in the pleadings or in the process, or in the judgment, upon which a writ, called a Writ of Error (breve de errore corrigendo), might, and in some cases may, still be brought to reverse the judgment. The proceeding of bringing error, which now in ordinary cases consists of simply suggesting that "there is error in the record and proceedings," is the ordinary mode of appeal from a court of record, and is in theory a commission from the crown to the judges of a court superior to that in which the judgment was given, by which they are authorised to examine the record, and on such examination to affirm or reverse the judgment according to law.

ERUCIC ACID ($C_{44}H_{42}O_4$), a colourless crystalline acid contained in the expressed oil of mustard (*Sinapis alba*). It fuses at 93° Fahr., is insoluble in water, but soluble in alcohol and ether.

ERYSI'PELAS (*Ignis Sacer, the Rose, St. Anthony's Fire*), an inflammation of the skin, occasioning a spreading redness, which occupies a broad surface, on which are formed vesicles or blisters, preceded by and accompanied with fever. The whole of the inflamed surface is painful; but the pain is not acute, it is rather a sensation of burning or stinging than of severe pain. The redness is not intense like that produced by phlegmon or boil, but is of a pale rose colour. There is always considerable tumefaction; the tumour is not surrounded by a definite boundary, but is diffuse, irregularly circumscribed, and unattended with a sensation of throbbing. The tumour is often soft and boggy. It is characterised by the vesications which form upon it.

The proper seat of erysipelas is the skin, but the appearance of the disease is somewhat modified according to the part of the skin which is more especially inflamed. If the rete mucosum, or the part of the skin which is placed immediately beneath the cuticle [SKIN], be the principal seat of the inflammation, the vesication is remarkable; there is commonly a considerable discharge from the vesicles, and a free exfoliation of the cuticle. If, on the contrary, the inflammation be chiefly seated in the cutis vera, or the true skin,—namely, that portion of the skin which lies immediately beneath the rete mucosum,—the cellular tissue beneath the skin is always more or less involved in the inflammation, and then the tumefaction is considerable on account of the infiltration of the cellular tissue with serum poured out from the blood by the inflamed cuticle.

Erysipelatous inflammation is characterised by its tendency to spread, and thereby to cover a considerable portion of the external surface of the body. It creeps on in succession from one part of the skin to another until it extends to a great distance from the part originally attacked, the inflammation often disappearing from the former as it becomes established in the latter. Sometimes the inflammation appears to pass from the external surface to the internal organs; and occasionally the disease quits the surface as it attacks the internal organs, although more commonly the external and internal inflammation go on simultaneously, greatly increasing the severity and danger of the attack.

Erysipelas most commonly attacks the face, but it sometimes seizes on one of the extremities. The disease is always more severe when it attacks the head than when it is seated in any other part of the body.

The inflammation which appears on the external surface of the body in erysipelas is not the primary and essential part of the disease, but a remote event depending on a preceding state of disease affecting the whole system. This is proved by the fact that constitutional disturbance always precedes, commonly for the space of two or three days, the appearance of the local affection.

An attack of erysipelas comes on either with chills or a distinct cold shivering, attended with a sense of lassitude, aching in the limbs, restlessness, and that disordered state of the skin which has been expressively termed febrile uneasiness. There is from the beginning uneasiness or confusion in the head, which soon amounts to decided pain. This is accompanied with such a degree of drowsiness that the attack may sometimes be predicted long before there is any appearance of redness or swelling in the face, from the inability of the patient to keep himself awake. The chilliness is soon succeeded by heat of skin; the appetite fails; the bowels are constipated; the tongue is dry and parched; there is sometimes nausea and vomiting; the pulse is always frequent, sometimes full, soft, and compressible, but occasionally hard and tense.

After these symptoms have continued some time, always one, generally two, and sometimes three days, there appears on some part of the face a redness, attended with burning heat and tingling. Commonly a red spot appears on one cheek; after a short time a similar spot appears on the other cheek; often the redness spreads successively from one cheek to the other across the nose, which is completely involved in the affection. From the nose it extends to the forehead, and thence over the whole scalp. Soon after the redness appears the face begins to swell; and by the second night or the morning of the third day from the commencement of the fever, the eyes are completely closed, the eyelids exceedingly prominent, the nose distended, and the ears tumid, red, shining, and burning. On the fourth or fifth day the vesications appear on the inflamed surface, which break on the fifth or sixth, when the redness changes to a yellowish hue. The whole face is now so turgid that the form and expression of the features are completely lost, and the patient could not possibly be recognised by his most intimate friends.

The surface of the skin in the blistered places becomes covered with a brownish or dark-coloured scab, which often gives a livid or blackish appearance to the part; but this livid colour seldom goes deeper than the surface, and does not proceed from any degree of gangrene affecting the skin. On the parts of the face not affected with blisters the cuticle is destroyed, and desquamates, a new cuticle being formed beneath it. Though the face, in general, however intensely inflamed, seldom goes into suppuration, yet it is by no means uncommon for matter to form in the tumid eyelids.

Occasionally, though not often, when erysipelas attacks the face, it extends to the mouth and fauces, and even to the pharynx and larynx, at the same time that it covers the neck and chest externally. Dr. Copland mentions a case in which the enormous tumefaction of the neck and throat with the affection of the larynx and trachea, increased by the constriction produced by the integuments surrounding the neck and throat, caused suffocation in a few hours. When the inflammation extends to the fauces, throat, and larynx, it sometimes produces a species of croup.

On whatever part of the body the inflammation appears in erysipelas, even when it is strictly confined to the skin, its appearance is not attended with any remission of the fever which preceded it: on the contrary, the fever generally increases with the augmentation and extension of the inflammation.

The progress of the disease is more or less rapid, and its duration longer or shorter, according to the age, the temperament, and the vigour of the individual. In the young, the sanguine, and the robust, the tumefaction is sometimes fully formed on the second day, and the whole terminates on the sixth or seventh, while in the aged and the less vigorous it may be protracted to the tenth or twelfth, and the desquamation may not be completed before the fourteenth day. The average duration of the disease may be stated to be from eight to ten days.

When the fever and inflammation are intense, delirium comes on, which sometimes rapidly passes into coma. These are most alarming symptoms, indicating a severe and too often a mortal inflammation of the brain. In such cases death frequently takes place, with many of the symptoms of apoplexy, on the seventh, ninth, or eleventh day of the disease. "In such cases," says Dr. Cullen, "it has been commonly supposed that the disease is translated from the external to the internal parts. But I have not seen any instance in which it did not appear to me that the affection of the brain was merely a communication of the external affection, as this continued increasing at the same time with the internal. When the fatal event does not take place, the inflammation, after having affected a part, commonly the whole of the face, and perhaps the other external parts of the head, ceases. With the inflammation the fever also ceases; and, without any evident crisis, the patient returns to his ordinary state of health."

In the cases which prove fatal, on the examination of the body after death, the inflamed skin is found infiltrated with serum, which is sometimes mixed with pus, and occasionally portions of the skin are found disorganised, and in a state of gangrene. It is remarkable that the blood in the large vessels and in the cavities of the heart is semifluid, and that the veins which proceed from the inflamed parts are in a state of inflammation, and contain pus, more especially when the inflammation has extended from the skin to the cellular tissue and has passed into suppuration. In the cases attended with delirium and coma the membranes of the brain, and especially the arachnoid, are thickened and opaque with the effusion of serum between the membranes and into the ventricles. If the disease has been complicated with inflammation of the fauces, pharynx, œsophagus, trachea, and bronchi, these organs present the ordinary signs of inflammation; and the same is true with regard to the mucous membrane of the stomach and intestines; but in all these cases the signs of inflammation are much more closely allied to those which occur in fever than to those which are proper to pure inflammation.

There is a peculiar condition of the skin which seems to predispose to erysipelas connected with the irritable or bilious temperament, and a plethoric habit of the body. The occurrence of the disease once renders the skin peculiarly susceptible to its recurrence. Unwholesome and indigestible food, the excessive use of spirituous liquors, the suppression of the excretions, and more especially the suppression of the perspiration, of the bile, and of the catamenial discharge, predispose to erysipelas.

The exciting causes are exposure to cold and moist air after the body has been previously heated; exposure to sudden and great alternations of temperature: exposure to great heat however produced, whether by the direct rays of the sun or by a fire; intemperance;

unwholesome articles of diet, as shell-fish, or stale and rancid fish; rich, oily, fat, or smoked meats; impure states of the atmosphere; an impure state of the body, arising from a morbid condition of the blood, in consequence of the suppression of its depurating processes, whence the frequent occurrence of the disease in the advanced stages of fever, greatly complicating the state of fever and exhausting the little remaining strength of the patient. Violent emotion of mind has also been observed to be an exciting cause of erysipelas in those powerfully predisposed to the disease; in whom also local irritants often induce it, as wounds or punctures in the skin, the bites of leeches, the stings of insects, inoculation with variolous or vaccine matter. Instances are on record in which both variolous and vaccine matter have produced in children of irritable habits, two or three days after inoculation, an erysipelatous inflammation which has proved fatal.

Erysipelas is a disease capable of being propagated by contagion. Dr. Bateman has noticed that in several hospitals it has prevailed in certain wards, among patients admitted with different complaints. Dr. Wells has collected several examples of the communication of erysipelas by contagion, which occurred in private families. Such cases are rare, and perhaps never happen in well ventilated and cleanly houses. From the Royal Infirmary, at Edinburgh, this disease, like the puerperal fever, has been banished by ventilation, white-washing, and other means of purification.

The danger of erysipelas is in proportion to the intensity of the inflammation, and the severity of the affection of the brain. The danger is also imminent when there is great tumefaction of the throat, or when the inflammation spreads to the respiratory passages and the respiratory organs. As long as the inflammation is confined to the external surface, and the fever remains moderate, the brain not much affected, and the heart's action not inordinate, a favourable termination of the malady may be expected. The different varieties or species of the disease are also attended with very different degrees of danger. Authors usually describe four species, namely, the phlegmonous, the œdematous, the gangrenous, and the erratic. The phlegmonous is that form of the disease in which the inflammatory state of the system is the most distinctly marked. In the œdematous the fever and inflammation are less intense; but the tumefaction is so great that the appearance of the face resembles that of a bladder distended with water. This form of the malady most commonly affects persons of debilitated constitutions, who have been previously attacked or are simultaneously affected with dropsy, or some other chronic disease, incident to a cachectic state of the system, and induced commonly by habitual intemperance. It is always attended with considerable danger, for the disorder of some internal function increases with the advancement of the external disease. Very frequently delirium and coma come on at the height of the disease, and terminate fatally on the seventh or eighth day; or, in other cases, the symptoms continue undiminished, and death occurs at a later period. When this form of the disease attacks one of the extremities, it is attended with but little danger.

In the gangrenous form of the disease the colour of the affected part is of a dark red, and scattered vesicles with a livid base appear upon the surface, which frequently terminate in gangrenous ulcerations. Suppuration and gangrene of the muscles, tendons, and cellular tissue often take place, producing little caverns and sinuses, which contain an ill-conditioned pus, together with sloughs of the mortified parts, which are ultimately evacuated from the ulcers. It is accompanied with symptoms of low fever, in the progress of which delirium comes on, soon followed by coma. It is always a tedious and precarious and often a fatal form of the disease.

In the erratic species the inflamed patches appear one after another in different parts of the body, thus travelling in succession from the face to the neck and trunk, and from the trunk to the extremities. It often happens that each accession of the complaint is less and less severe as it recedes to a greater distance from the part first affected, and this form of the disease commonly terminates favourably in a week or ten days.

In the phlegmonous species, characterised by the presence of inflammatory fever, the method of treatment must be widely different from that proper to the œdematous and gangrenous, in which there is the very opposite state of the system. In the young, the plethoric, the sanguine, and the robust, at the commencement of the attack, when there is much pain in the head, when the heat of the skin is intense, and the pulse is full and strong, the remedies proper in any other case of inflammatory fever are required. In such cases there is sometimes danger that the disease will terminate in fatal inflammation of the brain, unless there be a free abstraction of blood. But it must be borne in mind that erysipelas does not ordinarily occur in the youthful and vigorous constitution; that it is not often accompanied with the signs of acute inflammation; that blood-letting is required only when acute inflammation is present, and that the extent of the bleeding must be strictly regulated by the degree of the inflammatory action. In an ordinary attack of phlegmonoid erysipelas, general bleeding is not necessary, at least in the constitutions commonly found in a crowded city. Moderate purging, diaphoretic and saline medicines, strict confinement to bed in a cool apartment, with the diet appropriate to febrile diseases, are all the remedies required. If local bleeding and blistering appear to be indicated, care must be taken not to apply the leeches or the blister near the inflamed surface. Various applications to the inflamed surface have been recommended, the most common of which is flour, or some other absorbent powder, to imbibe the fluid which oozes from the vesications. The utility of such applications is doubtful. "The application of powdery substances," says Dr. Bateman, "has commonly, according to my own observation, augmented the heat and irritation in the commencement; and afterwards, when the fluid of the vesications oozes out, such substances produce additional irritation, by forming, with the concreting fluid, hard crusts upon the tender surface. In order to allay the irritation produced by the acrid discharge from the broken vesications, Dr. Willan recommends us to foment or wash the parts affected from time to time with milk, bran and water, thin gruel, or a decoction of elder-flowers and poppy-heads. In the early state of the inflammation, when the local heat and redness are great, moderate tepid washing, or the application of a cool but slightly stimulant lotion, such as the diluted liquor ammoniæ acetatis, has appeared to me to afford considerable relief." The local application of nitrate of silver is in some cases very beneficial.

In the œdematous species, when it occurs in broken-down constitutions, the result of habitual intemperance, even purgatives must be very cautiously administered; the strength must be sustained by mild nutritive diet and tonics, as cinchona or quinine, and even stimulants, as camphor, wine, or the beverage to which the patient has been habituated, are required. The aperients employed should be mild alterative mercurials, with equal parts of castor-oil and the spirit of turpentine administered perhaps every alternate morning.

In the gangrenous species, quinine in considerable doses through the whole course of the disease, opium, camphor, the mineral acids, wine, brandy, and the general regimen adapted to gangrenous affections occurring under other circumstances, must be freely employed. The remedies indispensable in the phlegmonoid species would be fatal in this form of the disease, while the remedies which afford the only chance of saving life in the latter would produce fatal inflammation of the brain if administered in the former.

ERYTHEMA, a superficial redness of some portion of the skin, varying in extent and form, attended with disorder of the constitution, without vesications, and uninfectious. It is distinguished from erysipelas by the slight degree of constitutional disorder, by the slight degree of local pain, by the more uniformly favourable termination of the disease, and by the absence of tumefaction and vesication.

Authors describe several species of this affection, namely:—

1. The fugacious (*Erythema fugax*), consisting of red patches of an irregular form, resembling the redness produced by pressure. These patches appear successively on the arms, neck, breast, and face. This affection is generally indicative of and produced by some disorder of the digestive organs.

2. The shining (*Erythema læve*), exhibits a uniformly smooth shining surface, and chiefly appears on the lower extremities in confluent patches. It is sometimes symptomatic of disorder of the digestive organs; occasionally attends the catamenia in delicate and irritable females, but most commonly accompanies anasarca or œdematous swellings. Under whatever circumstances anasarca occurs, so as greatly to stretch the skin, this Erythema is liable to be produced, and is often chequered with patches and streaks of dark red and purple hue. It commonly terminates in extensive desquamation of the skin, and may be considered as merely a modification of œdematous erysipelas.

3. Marginated (*Erythema marginatum*), occurs in patches which are bounded on one side by a hard elevated tortuous red border, in some places obscurely papulated; but the redness has no regular boundary on the open side. The patches appear on the extremities and loins in old people, and remain for an uncertain time, without producing any irritation in the skin. They are connected with some internal disorder, and may be considered as indicative of serious and dangerous diseases.

4. Papulated (*Erythema papulatum*), appears chiefly on the arms, neck, and breast, in irregular extensive patches, and most frequently in females and young persons. The patches are of a bright red hue, often slightly elevated; and for a day or two before the colour becomes vivid they are rough or imperfectly papulated. The redness afterwards continues for several days; and, as it declines, assumes, in the central parts, a bluish or pale purple tinge. This variety is generally attended by a tingling sensation, passing to soreness as the colour changes; and sometimes with much constitutional disturbance,—with a frequent small pulse, loss of appetite, depression of strength and spirits, watchfulness, and pains or tenderness of the limbs, but the general disorder is trifling.

5. Tuberculated (*Erythema tuberculatum*), is merely a slight modification of the advanced stage of the papulated.

6. Nodose (*Erythema nodosum*), consists of large oval patches on the fore part of the legs; the long diameter of the patch is parallel with the tibia; these patches slowly rise into hard and painful protuberances, and as regularly soften and subside in the course of nine or ten days. The red colour turns bluish on the eighth or ninth day, as if the leg had been bruised. It chiefly affects children, and particularly females, and is very seldom observed in boys. It is preceded by slight febrile symptoms for a week or more, which generally abate when the erythema appears. It is sometimes connected with the approach of the

catamenia, and its premature disappearance is not unfrequently succeeded by dangerous internal disease, as inflammation of the lungs.

The primary causes of erythema are the friction of contiguous parts, especially in fat persons; the accumulation of morbid secretions and excretions on the skin, as the matter of the perspiration, of the leucorrhœal discharge, of the catamenia, and of the alvine and urinary evacuations, in the adult in the course of other diseases; and in the infant in consequence of a want of proper ablution. It is also constantly produced by irritating articles of food and drink, and is the sign and the result of a disordered state of the digestive organs.

In most cases the affection disappears soon after the removal of the cause which produces it—by free ablution where it is the result of irritating matters on the skin; its disappearance is assisted sometimes by the application of an absorbent powder to the inflamed surface, and at other times by the use of a gentle stimulating lotion, as the spirit wash. When the disease is dependent on a disorder of the digestive organs, it can be removed only by the remedies proper for the removal of the stomachic, the hepatic, or the intestinal derangement. For the restoration of these organs to their sound condition, the most appropriate remedies are light diet, diaphoretics, the mercurial alteratives in combination with gentle aperients, and the mineral acids as tonics. (Bateman's 'Practical Synopsis of Cutaneous Diseases;' Copland's 'Dictionary of Practical Medicine.')

ERYTHRELLIC ACID. [ERYTHRIC ACID.]

ERYTHRIC ACID ($C_{32}H_{16}O_{16}$?). *Erythrin.* This acid was first discovered by Heeren in the *Roccella tinctoria*, a lichen from which is prepared a colour used in dyeing. It has since been found in other lichens used for the same purpose, and has been particularly examined by Stenhouse and Schunk. From erythric acid are derived *Erythrellic acid*, *Picroerythrin*, and *Erythro-mannite*. *Orcin* is also a derivative, but as it likewise exists ready formed in several of the lichens, and is moreover of considerable importance, it will be treated of in a separate article. [LICHENS, COLOURING MATTERS OF.]

Erythric acid may be readily obtained from the *Roccella* in which it exists to the extent of ten or twelve per cent., by digesting that lichen in water for a few hours, and then adding slaked lime. The acid unites with the lime, forming a salt that dissolves in the water. To the strained liquor hydrochloric acid is added, which precipitates the erythric acid in a gelatinous state. Collected on a filter, washed with a little cold water, the water removed by pressure, and the cake dissolved in warm alcohol, the acid is obtained on cooling in stellate groups of acicular crystals. The acid must not be boiled with alcohol, or a compound ether is formed.

Erythyric acid is colourless, tasteless, and odourless; it is soluble in 140 parts of boiling water, almost insoluble in cold water, and tolerably soluble in warm alcohol or ether. By heat it is decomposed, orcin at the same time being produced as a sublimate. Long boiling with water converts erythric acid into *picroerythrin*, with evolution of carbonic acid,

$$\underbrace{C_{32}H_{16}O_{16}}_{\text{Erythric acid.}} + 4HO = 2CO_2 + \underbrace{C_{30}H_{20}O_{14}}_{\text{Picroerythrin.}}$$

Erythric acid is precipitated by subacetate of lead; the compound formed contains 59·12 per cent. of oxide of lead.

Erythric acid dissolves in ammonia, yielding on exposure to air a deep purplish-red solution. It also dissolves in the fixed alkalies and their carbonates, from which solutions stronger acids reprecipitate it unchanged. Continued ebullition with baryta or lime coverts it into orcin, with production of a carbonate of the base:—

$$\underbrace{C_{32}H_{16}O_{16}}_{\text{Erythric acid.}} + 4BaO = 4(BaO, CO_2) + \underbrace{2(C_{14}H_8O_4)}_{\text{Orcin.}}$$

Erythrellic acid is produced to a greater or less extent during the process just mentioned. It crystallises in small thin plates, and is very similar, if not identical, with orcellic acid.

Picroerythrin ($C_{30}H_{20}O_{16}$?) is, as before indicated, a product of the action of boiling water on erythric acid. On concentrating the solution it is deposited in yellowish crystals, which may be obtained colourless by re-solution in boiling water and treating with animal charcoal.

Picroerythrin is very soluble in hot water, sparingly so in cold. It has a very bitter taste, is not altered by prolonged boiling with water, does not etherify alcohol, readily dissolves in the fixed alkalis, and by heat gives a sublimate of orcin. Its solution in ammonia rapidly becomes red on exposure to the air. Boiled with baryta, or lime-water, picroerythrin is converted into orcin, *erythro-mannite*, a carbonate of the base, being at the same time formed.

$$\underbrace{C_{30}H_{20}O_{16}}_{\text{Picroerythrin.}} + 4HO + 2BaO = 2(BaO, CO_2) + \underbrace{C_{14}H_8O_4}_{\text{Orcin.}} + \underbrace{C_{14}H_{16}O_{12}}_{\text{Erythro-mannite.}}$$

Erythro-mannite ($C_{14}H_{10}O_{12}$ + Aq. ?), (*pseudo-orcin*, *erythro-glucin*,) may be obtained directly from the *Roccella* by boiling for several hours in lime-water, filtering, removing the lime by a current of carbonic acid, and concentrating the liquid to a syrupy consistence. From the cold gummy mass orcin is extracted by alcohol or ether, and the erythro-mannite obtained pure by re-crystallisation from boiling alcohol.

Erythro-mannite is very soluble in water, the solution yielding on evaporation very fine pyramidal crystals. It has a sweet taste, but is not fermentable. It is neutral to test-paper.

The name erythro-mannite was given to this compound by Stenhouse on account of its properties being very analogous to those possessed by mannite. [MANNITE.] Its homology with mannite is further confirmed by its yielding under similar circumstances a body very like nitro-mannite.

Nitro-erythro-mannite ($C_{14}H_{10}(NO_4)_6O_{12}$?) is obtained by dissolving erythro-mannite in fuming nitric acid, kept perfectly cold. On adding rather more than an equal bulk of strong sulphuric acid, and setting aside the mixture for a short time, a large quantity of minute crystals are formed; these may be separated from the mother liquor by draining in a funnel plugged with asbestos, and washing with water. From solution in alcohol the compound is obtained in beautiful crystals resembling benzoic acid.

Nitro-erythro-mannite fuses at 142° Fahr.; at a higher temperature it burns with slight deflagration. Mixed with a little sand, and placed on an anvil, it detonates violently on being struck with a hammer. Its solution is quite neutral to test-paper.

ERYTHRIN. [ERYTHRIC ACID.]

ERYTHRO-GLUCIN. [ERYTHRIC ACID.]

ERYTHROLEIC ACID (?), an acid of uncertain composition, said to be contained in *Roccella tinctoria*.

ERYTHROLEIN. [LICHENS, COLOURING MATTERS OF.]

ERYTHROLITMIN. [LICHENS, COLOURING MATTERS OF.]

ERYTHRO-MANNITE. [ERYTHRIC ACID.]

ERYTHROPHYLLE, the substance to which the autumnal red tint of some leaves is due. It is soluble in water and alcohol. Alkalies colour it brown, whilst salts of lead precipitate it of a beautiful green colour.

ERYTHROPROTIDE, a red extractive matter of uncertain composition, obtained from albuminous substances.

ERYTHROZYME. [MADDER, COLOURING MATTERS OF.]

ERYTRARSIN ($C_8H_{12}As_6O_6$), a red amorphous substance formed when cacodyl is burnt with a supply of air insufficient for its perfect combustion.

ESCAPEMENT. [HOROLOGY.]

ESCARP, or SCARP, in fortification, is that side of the ditch surrounding or in front of a work, and forming the exterior of the rampart. In field-works the escarp is usually formed by cutting the earth at such an inclination as will permit it to support itself, which may be at 45 degrees with the horizon, or more, according to the tenacity of the soil; and, to impede the enemy in attempting an assault, fraises or inclined palisades are frequently planted on the slope. In large fortresses the escarp is the exterior surface of the revetment wall which supports the rampart, and it is frequently formed at such an inclination that the base of the slope is to its height as 1 to 6; that is, it has a slope of ⅙. But engineers at present recommend that the exterior surfaces of both the escarp and counterscarp revetments be made vertical, in order to lessen the action of the weather upon the brick-work, and to prevent the formation of vegetation on the disintegrated brick-work and the accumulated dirt in the joints. [REVETMENT.]

ESCARPMENT, a precipitous side of any hill or rock. In military operations ground is frequently scarped, as it is called, or cut away nearly vertically about a position, in order to present an obstacle to an enemy. Part of the rock of Gibraltar has been rendered inaccessible in this manner; and in the execution of the entrenchments about Lisbon, in 1810, the British troops formed an escarpment from 15 to 20 feet high, and about two miles long, on the brow of a ridge of heights extending from Alhandra to the valley of Calandrix, in order to secure the line against an attack at that part. A similar work was executed along a ridge of hills between Mafra and the mouth of the S. Lorenzo.

ESCHAROTICS (ἐσχαρωτικά, from ἐσχαρόω, to form a crust, or scab) are agents applied to the surface of the body, which destroy the vitality of the part which they touch, and produce an eschar. This effect they occasion either by combining chemically with the animal matter, or by destroying the old affinities, and causing the elements of the part to enter into new combinations. Their action is more energetic in proportion to the degree of vitality of the part to which they are applied. They are classed under two heads, the *potential* cauterants, and the *actual* cautery: the former are chiefly chemical agents, and form new compounds with the elements of the part with which they come in contact; but some merely cause irritation and augmented absorption, and are distinguished as *erodents*. The actual cauterants are substances of an elevated temperature, which decompose the part which they touch, and completely destroy its organisation.

The chief potential cauterants are strong mineral acids, such as the sulphuric or nitric, pure alkalies, and some metallic salts, especially nitrate of silver, or lunar caustic. These are used either to produce counter-irritation, or to remove fungus or morbid growths. Lunar caustic seems to possess peculiar properties, and is unquestionably the most powerful *direct* antiphlogistic agent known. If applied in the solid state to many inflamed parts it speedily checks the morbid action, and is decidedly the best application to chilblains, and in leucorrhœa. The actual cauterants are used either for their primary action, viz., the immediate destruction of the part, or for their secondary effects. The former object is rarely attempted, except to prevent the absorption of any poisonous or contagious matter, such as the venom of a snake, or bite of a mad dog. The secondary effects are more important, and more varied according to the degree of heat of the substance applied. The first effect is pain more or less severe, a flow of blood towards the part, and more rapid performance of the process of interstitial deposition and absorption, terminating in inflammation, extending to a greater or less depth, according to the intensity of the heat, or form of the body employed. This increased action has often a salutary effect, which is frequently felt through the whole frame. Torpor and paralysis of the nervous system often disappear, and neuralgia both of the neighbouring and even distant parts is removed. Atony and laxity of the muscular system vanish, and every part displays more energy and power.

The actual cautery may be applied in a variety of ways, viz., hot water, hot vapour, moxa, and heated iron. The first of these is a very ready means of causing vesications in some diseases. In phthisis pulmonalis, or consumption, where pain is often more relieved by vesication than any other means, placing a sponge in a wine-glass, and pouring boiling water on it, then suddenly inverting the glass over the part of the chest where the pain is felt, will cause immediate vesication, followed by speedy relief. The vapour of boiling water, as it issues from the spout of a kettle, is also a convenient method of applying heat in inflammations of the joints, as in gout, morbus coxarius, and other deep-seated diseases of the bones. As the red-hot iron is now seldom used, being confined to veterinary medicine, moxa affords the best substitute, and it is very convenient as any degree of intensity or rapidity of action can be given to it. [Moxa.]

The eschar which follows the application of the potential or actual cautery generally separates in a few days. The ulcer is then to be treated with different agents, according as it is wished to heal it or keep it open, as a farther means of counter-irritation.

ESCHEAT, from the Norman French word *eschet* or *echet*, chance or accident (a word derived from *escheoir*, the old French form of the verb *échoir*, "to fall"), is defined by Sir William Blackstone as an obstruction to the course of descent by some unforeseen contingency which consequently determines the tenure. In this case the land results back by a kind of reversion to the original grantor or lord of whom it is holden.

Escheat takes place when the tenant of lands dies intestate and without an heir: in such case the lands, if freehold, escheat to the king, or other lord of the fee; if copyhold, to the lord of the manor. Lands which have descended to the last tenant from a paternal or maternal ancestor, escheat, if there are no heirs on the part of that ancestor from whom the lands descended. Since the 1st day of January, 1834, there can be no escheat on failure of the whole blood, wherever there are persons of the half-blood capable of inheriting, under 3 and 4 Will. IV., c. 106.

If a bastard dies intestate and without issue, his lands escheat to the lord of whom they are held.

Escheat also takes place upon attainder for treason and murder, by means of which the blood is in law considered to be corrupted, and the attainted owner of lands rendered incapable of holding them himself, or transferring them by descent. In consequence of this extinction of heritable blood, the lands of such felons revest in the lord, except in cases of treason, when a superior law intervenes, and they become forfeited to the crown. Previously to the statute (3 & 4 William IV., c. 106) a person could not trace his descent through another person who had been attainted; but this may now be done, provided that other person shall have died before such descent shall have taken place. [Attainder.] And by the 4 & 5 William IV., c. 23, no property vested in any trustee or mortgagee shall escheat or be forfeited by reason of the attainder or conviction for any offence of such trustee or mortgagee, except so far as such trustee or mortgagee may have a beneficial interest in such property.

This doctrine of escheat consequent upon the commission of certain crimes is derived from the feudal law, by which a vassal was only permitted to hold real property upon condition of well demeaning himself.

The doctrine of escheats, with regard to extinct successions, seems to have been adopted in every civilised country, to avoid the confusion which would otherwise arise from the circumstance of any property becoming common; and the sovereign power, or those who claim under it, are consequently the ultimate heirs to every inheritance to which no other title can be found.

ESCHEATOR, an ancient officer, so called because his office was to look after escheats, wardships, and other casualties belonging to the crown.

There were at first only two escheators throughout England, one on this side and the other beyond the Trent; but in the reign of King Edward III. there was one appointed for every county, who was to continue in office for one year only. This office has long ceased to exist.

ESCROW. [Deed.]

ESCUAGE, or SCUTAGE, a pecuniary payment, by way of commutation for the knight-service, whereby the tenant was bound to follow his lord into the wars at his own charge. The term is derived from the Latin *scutum*, 'a shield.'

The personal attendance due by knight-service growing troublesome and inconvenient, the tenants found means of compounding for it, first by sending others in their stead, and in process of time by making a pecuniary satisfaction to the lords in lieu of it. This ultimately came to be levied by assessments, at so much for every knight's fee; and therefore this tenure was called *scutagium* in Latin, or *servitium scuti*; as being a pecuniary substitute for personal service. The first time it appears to have been taken was by Henry II., on his expedition to Toulouse; but it soon came to be so universal, that personal attendance fell into disuse. From this period, when our kings went to war, they levied scutages on their tenants, that is, on all the landholders of the kingdom, to defray their expenses and hire troops; and these assessments, in the time of Henry II., seem to have been made arbitrarily and at the king's pleasure. This prerogative being greatly abused by his successors, it became matter of national complaint, and King John was obliged to consent, by his *Magna Charta* (c. 12), that no scutage should be imposed without consent of parliament. This clause was omitted in Henry III.'s charter; where we only find (c. 37), that scutages should be taken as they were used to be taken in the time of Henry II.; that is, in a reasonable and moderate manner. Afterwards by 25 Edw. I. c. 5 & 6 and many subsequent statutes, it was enacted, that the king should take no aids or tasks but by the common assent of the realm. Hence it is held that scutage could not be levied but by consent of parliament, such scutages being indeed the groundwork of all succeeding subsidies, and of the land-tax of later times.

ESCULETIN. [Esculin.[

ESCULIC ACID. *Saponic Acid, Sapogenin.* By adding a little hydrochloric or sulphuric acid to a boiling solution of Saponin, a white substance is precipitated, to which M. Fremy gave the name esculic acid, and the formula $C_{52}H_{46}O_{24}$. According to Rochleder and Schwartz, it is identical with *quinovatic acid* ($C_{12}H_{10}O_4$), whilst M. Bolley terms it, *sapogenin*, and gives it the formula $C_{24}H_{18}O_{10}$.

Esculic acid presents the appearance of white granular tasteless crystals scarcely soluble even in boiling water, insoluble in ether, but easily soluble in alcohol. It forms salts with bases, and is transformed into a yellow resin by nitric acid.

ESCULIN. *Polychrome.* A neutral crystalline substance found in the bark of the horse-chestnut tree [Æsculus, in Nat. Hist. Div.], [Pavin]. The aqueous infusion of the bark is treated with excess of acetate of lead, and the filtered liquor, after removing excess of lead by sulphuretted hydrogen, evaporated till of a syrupy consistence; after a few days the esculin crystallises out, and may be purified by recrystallisation, first from dilute alcohol (sp. gr. ·940), and then from boiling water.

The formula of esculin, after drying in a water-oven, is $C_{42}H_{24}O_{26}$. It crystallises in small colourless needles, without odour, and of a bitter taste. It is very soluble in hot water, less so in alcohol, and but slightly soluble in ether or cold water. It fuses at 320° Fahr., at a higher temperature decomposes, emitting an odour of caramel, and yields a small quantity of a crystalline sublimate (*esculetin*).

Solutions of esculin are remarkable for their high fluorescent power, appearing of a deep blue colour by reflected light, while by transmitted light they are colourless. This property still obtains in a solution containing only one part of esculin to one and a half million parts of water.

Esculin is one of the so-called *glucosides*, that is, by the action of boiling dilute acids, or of the ferment emulsin, it splits up into glucose (grape sugar), and *esculetin*, according to the following equation:—

$$\underbrace{C_{42}H_{24}O_{26}}_{\text{Esculin.}} + 6HO = \underbrace{C_{18}H_6O_8}_{\text{Esculetin.}} + \underbrace{2C_{12}H_{12}O_{12}}_{\text{Glucose.}}$$

Esculetin is but slightly soluble in water or alcohol, but freely so in either, if boiling. It forms small acicular or micaceous crystals. Solutions of acetate of lead and of esculetin, yield a lemon-yellow precipitate, in which two of the six equivalents of hydrogen in esculetin are substituted by two equivalents of lead.

ESCUTCHEON or ESCOCHEON, the heraldic term for the shield, on which, under every variety of shape, arms are emblazoned. The word is derived from the French *écusson*, and that from the Latin *scutum*. The first representation of arms was, no doubt, as an ornament to the shield. The shield afterwards became the appropriate and legitimate instrument for displaying them; hence in sculpture and painting they were never separated; and when shields ceased to be employed, their form remained, and still continues to be the field on which coat-armour is invariably depicted. An *escutcheon of pretence* is the small shield in the centre of his own, on which a man carries the coat of his wife, if she is an heiress and he has issue by her. In this case the surviving issue will bear both coats quarterly.

ESENBECKINE. An alkaloid of uncertain composition, said to be contained in the bark of the *Esenbeckia febrifuga*.

ESOTERIC. [Exoteric.]

ESPALIER, a trellis for training fruit trees or bushes upon, instead of nailing them to walls.

In certain situations this kind of training is not only extremely neat, but possesses peculiar advantages: the trees are more fully exposed to the influence of light, less liable to be broken by high winds, and in small gardens in particular, where room is of great importance, and where a collection of the finer sorts of fruit is always desirable, it is found highly useful, both on account of the small space which the trees occupy, and because they will bear fruit much sooner than when allowed to grow in their natural form.

In France and other parts of the continent this kind of training is very much practised, and in the northern parts of England and in Scotland, where the borders of the kitchen-garden are frequently planted with flowers, in order to combine pleasure with utility, espaliers are trained along the back of the flower borders to prevent the vegetables being seen from the walks.

When the espalier is fastened to a wall, as is very common on the continent, peach and nectarine trees are frequently trained upon it; but where it is detached, as it is most commonly in Britain, apples and pears, and sometimes gooseberries, are the only fruits which are successfully cultivated in this way. Plums and cherries are occasionally so managed, but not so advantageously as the others.

When a common espalier is to be covered, the trees should be planted from 20 to 24 feet apart, which will allow the branches to grow 10 or 12 feet on each side; but as a considerable time would elapse before they would fill this space, a duplicate tree may be planted between each, and cut away as the others grow. Gooseberries, of course, require a small space; three or four feet from plant to plant is sufficient.

The training on espalier is very simple, and easily performed. When the trees are young, one shoot must be trained perpendicularly, and two others horizontally, one from each side; the two last must not be shortened, but the perpendicular shoot is to be shortened in the following year to three good buds, two of which are to form new side branches, and the other a leader as before; and so on every year until the trees have attained the desired size. The proper distance between the horizontal branches must depend upon the peculiar growth of the tree, but from six to nine inches is what is generally allowed. Trees are sometimes trained upon a double espalier, which has the advantage of giving two surfaces to train upon. It consists of two trellises instead of one, about two feet apart at the bottom, and approaching at the top.

The only kind of espalier worth notice, which differs from those now mentioned, is a table rail; this, the management of which is called table-training, consists of rails resembling tables, up the centre of which the tree is trained, and regularly spread over the surface. It is rarely employed, and has the essential fault of exposing the blossom so much to the effect of nocturnal radiation, that in this country a crop is rarely obtained from such espaliers.

The stakes which form the espalier are made of different materials, some of wood, others of wire and wood, and some of cast iron. The first of these is by far the most simple, and is composed of stakes, five or six feet in height, driven into the ground from one to two feet apart; along the top a bar, which is nailed to each, connects the whole together. It is of no use to have the stakes either so strong or so high when the trees are first planted, because they are not required, are unsightly, and will have to be renewed before the trees have attained their intended height; for this reason, stakes of a much weaker kind will at first answer quite as well. The wire and wood rail is formed by strong vertical wires, strained from two wooden horizontal rails, which are connected and held fast by wooden posts let into the ground. The iron rail is constructed upon the same plan as a common street railing.

The objection to all iron trellises is, that they cut and canker the trees; and when the cheapness of the wooden one is considered, besides the more natural appearance which it presents, it must undoubtedly have the preference.

The best wood for this purpose is young larch, the thinning of plantations.

ESPLANADE, the ground kept open between the fortifications of a citadel and those of a town to which it belongs. It is recommended by writers on fortification that this space should be about 300 fathoms broad, reckoning from the covered way of the citadel, that in the event of an attack on the latter the enemy may not construct batteries within breaching distance under the cover afforded by the buildings of the town. If however the ground should be built over, it would be advisable to clear it to that extent in case of a siege.

ESQUIRE (from the French, *Escuier*, or shield bearer) is the next title of dignity to that of knight. The esquire was the second in rank of the aspirants to chivalry, or knighthood, and had his name from carrying the shield of the knight, whose bachelor or apprentice in arms, he was. The gradations of this service, or apprenticeship to arms, were, page, esquire or bachelor, and knight, who, in his turn, after the formation of degrees of knighthood, was called a knight bachelor, as aspiring to the higher honours of chivalry. The esquire was a gentleman, and had the right of bearing arms on his escutcheon or shield; he had also the right of bearing a sword, which denoted nobility or chivalry, though it was not girded by the knightly belt; he had also a particular species of defensive armour, which was distinguished from the full panoply of the knight. So much for the esquire of chivalry, which order is only preserved in the almost obsolete esquires for the king's body, whom antiquaries have pronounced to be the king's esquires in chivalry (that is, his esquires, as being a knight), and in the esquires of knights of the Bath.

There was also another class, who may be called feudal esquires, and consisted of those tenants by knight's service who had a right to claim knighthood, but had never been dubbed. They were in Germany called *Ritters*, or knights, but were distinguished from the actual knights, who were called dubbed knights, or *Ritter Geschlagen*, and had many of the privileges of knighthood. This distinction still exists in many of the countries which formed part of the German Empire. In Hainault, Brabant, and other provinces of what was Austrian Flanders, the ancient untitled nobility, or gentry as they are called in England, to this day are styled collectively the *Ordre Equestre*, or knightly order. It also existed in England until James I. had prostituted the honour of knighthood, for Camden frequently speaks of knightly families (*familias equestres*, or *familias ordinis equestris*), where the heads of them were not, at the time, actual knights. Writers on precedence make mention of esquires by creation, with investiture of a silver collar or chain of *ss*, and silver spurs: but these seem to have been only the insignia of the esquires for the king's body, which being preserved in a family as heir looms, descended with the title of esquire to the eldest sons in succession. The sons of younger sons of dukes and marquesses, the younger sons of earls, viscounts, and barons, and their eldest sons, with the eldest sons of baronets, and of knights of all the orders, are all said to be esquires by birth, though their precedence, which differs widely, is regulated by the rank of their respective ancestors. Officers of the king's court and household, and of his navy and army, down to the captain inclusive, doctors of law, barristers, physicians, and Royal Academicians, are reputed esquires. A justice of the peace is only an esquire during the time that he is in the commission of the peace, but a sheriff of a county is an esquire for life. The general assumption of this title by those who are not, in strictness, entitled to it, has virtually destroyed it as a distinct title or dignity. The heads of many old families are, however, still deemed esquires by prescription.

ESSAYISTS, BRITISH. This title is customarily confined to a certain class of periodical writers upon subjects of general interest, as morals, criticism, manners, &c. The notion of a series of papers fit for general circulation, and not including news or politics, was originated by Steele and Addison in the 'Tatler.' [ADDISON, in BIOG. DIV.] The 'Freeholder,' 'Craftsman,' 'Freethinker,' &c., now almost forgotten, were rather political pamphlets than essays in this sense of the word; and an interval of thirty-five years elapsed from the end of the 'Spectator' to the successful revival of this style of writing by Dr. Johnson, in the 'Rambler,' in 1750. Its great popularity led to the establishment of a number of similar periodicals during the latter half of the 18th century, since which time they have again gone out of fashion. We give a list of those contained in Alexander Chalmers's collective edition of British Essayists, which includes some that have little claim to a place among the standard works of our language: with the names of the principal and most celebrated contributors to each:—

'Tatler'—Steele, Addison.
'Spectator'—Addison, Steele, Budgell, Pope, &c.
'Guardian'—Steele, Addison, Berkeley, Pope, Tickell, Gay, &c.
'Rambler'—Johnson, almost entirely.
'Adventurer'—Hawkesworth, Johnson, Joseph Warton, &c.
'World'—Moore, Lord Chesterfield, Horace Walpole, J. Warton, &c.
'Connoisseur'—G. Colman and Bonnel Thornton chiefly; Cowper a few.
'Idler'—Johnson; a few by Warton and others.
'Mirror'—Henry Mackenzie and others.
'Lounger'—The same.
'Observer'—Richard Cumberland, almost entirely.
'Olla Podrida'—Moore, &c.
'Microcosm'—Canning, Frere, Smith, &c.

ESSENCE is derived from the Latin *essentia*, a word which is used by Cicero and Quinctilian, and formed, not as is stated in Mr. Richardson's Dictionary, from *existentia*, but from *essens*, the analogous but obsolete participle of the verb *esse*, to be. The English word essence consequently signifies that which constitutes the being of a thing, or, in the words of Locke, that which makes it to be what it is. This term was the subject of many very subtle disquisitions and disputes among the scholastic logicians of the 14th, 15th, and 16th centuries; and the metaphysical notions of essence entertained by these logical doctors cannot be understood without reference to their discussions respecting the nature of universal ideas, as real or nominal, of abstraction, genus, species, differentia, substance, properties, accidents, &c., of all which particulars may be found in Smiglecii 'Logic. Disputat.'; Burgersdicii 'Logica;' Eustachii 'Logica;' Le Grand, 'Institut. Logic.'; Wallisii 'Logica'; and in many other logical and philosophical treatises cited in Johnson's 'Quæstiones Philosophicæ,' p. 168, &c. Some amusing instances of metaphysical sagacity concerning logical essence are exhibited in the scholastic work of Louis de Lesclache, 'La Philosophie, divisée in cinque Parties,' 1548.

"Il n'y a rien dans la substance qui ait moins d'essence que la substance; aussi il n'y a rien dans la substance qui soit moins substance que la substance," &c. In the 'Oxford Manual of Scholastic Logic,' by Dr. Aldrich, as expounded by Mr. Huyshe, it is taught, in accordance with the theory of the Nominalists, that essence is not really existent, but is merely a figment of imagination, and that the notion of it is resolvable into two parts; that which is common to other essences being called the *genus*, and that which is peculiar to one particular essence, distinguishing it from all others, and constituting it what it is, being called the *differentia*. The whole essence is called the species; that is, genus + differentia = species. The qualities joined to essence are also of two kinds; those which are joined necessarily are called *properties*, and those which are joined only contingently are called *accidents*. Hence the five predicables, or only possible parts of a thing which can be the objects of assertion:—1. Species or whole essence. 2. Genus, the common or material part of the essence. 3. Differentia, the peculiar or formal part of the essence. 4. Property or quality necessarily joined to the essence. 5. Accident, or quality contingently joined to the essence. The following statements collected from Locke's 'Essay,' book iii., c. 3 and 6, exhibit the principal points of his doctrine of essence. He considers essence to be of two kinds: 1. The real essence, which constitutes the insensible parts of a thing, and is wholly unknown to us. 2. The nominal essence, which depends on that which is real, and is the complex idea, for instance, of the properties of colour, weight, malleability, fixedness, fusibility, &c., expressed by the word gold; for nothing can be gold which has not the qualities conceived in the abstract idea to which this name is applied. In simple ideas (see book ii. c. 2), the real and nominal essence are identical, but in substances they are always different. Each of the distinct abstract ideas which men make and settle in their minds by giving them names, is a distinct essence; and the names which stand for such distinct ideas are the names of things essentially different. Thus, a circle is as essentially different from an oval as a sheep from a goat; the abstract idea which is the essence of one being impossible to be communicated to the other. As essences are nothing but the abstract complex ideas to each of which has been annexed a distinct and general name, and as of such ideas there are some which correspond to no reality in nature—for instance, those of mermaids, unicorns, &c.—it is evident that there are essences of things which have no existence. In considering essence with regard to the scholastic theory of genus and species, Locke observes that we classify things by their nominal essences, having no other measure of essence and species but our abstract general ideas or mental archetypes, without reference to which we cannot intelligibly speak of essential and specific difference. The doctrine of the immutability and ingenerable incorruptible nature of essences can be founded, says Locke, only on the relation between abstract ideas and the sounds by which they are signified; that is, on the fact that the same name retains the same signification, and also on the fact that, whatever may become of individuals, as Alexander and Bucephalus, the ideas of man and horse remain unaltered. Some of these positions, as that real essences are unknown, and that species are distinguished by essences merely nominal, are disputed in Green's 'Philosophy' and Lee's work against Locke. (See also many of the earlier scholastics; and for an exposition of the doctrine of essence, according to the transcendental theory, see Kant's 'Kritik der reinen Vernunft' and Wirgman's 'Logic and Metaphysics' in the 'Encyclopædia Londinensis.') Substance, as distinguished from essence, is understood to mean all the essential, with the accidental qualities; and essence (genus and differentia, or common and proper) the essential qualities alone, that is, the pure substance, or metaphysical substratum. The Greek word *ousía* (*οὐσία*) has many significations applicable to the individual, genus, species, and subject (Aristotle, 'Metaphys.' l. 6, c. 3); on which it is remarked by Roy Collard 'Essai sur la Psychologie,' 1826, p. 149, 246), that while the Latin and all modern languages have two distinct expressions for essence and substance, it is surprising that the Greek, which is otherwise so rich, had only one name (*οὐσία*) for these two ideas. The word *ὑπόστασις, hypóstasis* (substance), was subsequently employed, but with similar duplicity and confusion. Hence arose many of the Trinitarian controversies, or rather logomachies, which embroiled the first ages of the church; for Athanasius, Epiphanius, and most of the other Greek fathers understood *πρόσωπον*, person or mode of being, as meaning the same thing as *ὑπόστασις*, substance; and Sabellius, Arius, Nestorius, and Eutyches understood *ὑπόστασις*, as signifying the same thing as *οὐσία*, that is, essence or nature. So that Sabellius said, there is one essence or nature in God, *therefore* one substance or person. There are three substances or persons in God, said Arius, *therefore* three essences or natures. There are two essences or natures in Christ, said Nestorius, *therefore* two substances or persons. There is but one substance or person in Christ, said Eutyches, *therefore* but one essence or nature. The essay on the difference between *οὐσία* and *ὑπόστασις*, essence and substance, which is often attributed to St. Gregory, appears to belong rather to St. Basil; at least it is contained in his 43rd epistle. The epithet *essential* denotes those indispensable qualities in a thing, without which it could not be what it is; and the name *essentials*, as the essentials of logic, signifies those parts alone which are valid for general or particular uses.

ESSENCES. In various departments of manufactures, as well as in pharmacy and perfumery, liquids are largely sold under the name of essences. Originally the word was employed to denote the active and characteristic portion of any substance, or that on which its special properties mostly depend; but in the present day the term is very loosely applied. Sometimes essence is equivalent to *fluid extract*, sometimes to *volatile oil*, at other times to *strong solution*, to *concentrated preparation*, to *infusion*, to *decoction*, and to *tincture*. The essences of the pharmaceutist consist, in some instances, of the active ingredient of the plant digested in spirit; in others, of a solution of the essential oil in spirit; in others, of the volatile or aromatic element obtained by distillation. Among the large number of essences now made and sold, a few may be named useful in the arts, besides those pertaining more especially to medicine. Essence of allspice or pimento is used to make pimento-water, and as a flavouring ingredient in cookery and confectionery. Essence of almonds is used to impart an agreeable flavour and aroma to wine, cordials, perfumery, and pastry; to prepare almond-water and other liquids; to give a sherry flavour to Cape wine, and sometimes to sophisticate sherry itself. Essence of ambergris is a powerful ingredient in many perfumes, and is also added in the preparation of sweet-scented wines and spirits. Essence of aniseed is used to flavour liquors, and to make aniseed-water. Essence of cardamom is a powerful ingredient for flavouring cordials and pastry. Essence of cognac, made from brandy oil and spirit, is used to give to British spirit an imitative flavour of real brandy. Essence of grape is used to flavour brandy. Essence of hop is used occasionally to add a stomachic bitter to a glassful of ale or beer. A so-called essence or extract of hop is, however, not unknown to brewers as an adulterant, consisting of bitter preparations of quassia, gentian, camomile, aloes, or wormwood, not containing a particle of hop. Essence of ratafia is employed in the preparation of the liquors called ratafia and noyeau. Essence of rosemary, besides its use as a perfume, is employed in making rosemary-water. Essence of spruce is used in making spruce-beer. There are numerous other essences employed to impart flavour or odour to beverages, perfumery, or pastry; among which may be named the essences of apple, bergamot, carraway, cedrat, celery, cinnamon, cloves, jasmine, jonquil, lavender, lemon, lemon-peel, myrtle, nutmeg, orange, orange-peel, patchouli, pear, peppermint, pine-apple, rondeletia, rose, vanilla, verbena, violet, &c. There are also certain essences, so-called, obtained from animal substances, and applied to various purposes: of which a few may here be briefly noticed. Essence of anchovies consists of the substance of the fish, when the bones have been removed, pulped and sifted, and simmered for a few minutes in a liquid in which the bones have been boiled, and to which salt, flour, and vinegar are added. Essence of anchovies, improperly so named, is sometimes made from pickled sprats or young pilchards, mixed with the drainings of anchovy barrels or with herring liquor; it is coloured with Venetian red or Armenian bole, which is not only an adulterant, but an injurious one. Essence of beef consists of the nutritive portions of the meat, concentrated into a liquid by decoction and infusion, and preserved in well-closed bottles. Essence of civet and essence of musk, prepared from parts of certain animals, take rank among the list of perfumes. Essence d'Orient, prepared from a pearly-looking substance found at the base of the scales of the blay or bleak fish, is employed as an inner coating for glass bubbles or beads, to make artificial pearls. Essence of turtle is a miscalled preparation, in which, by combining essence of anchovies with many other substances, a liquid is produced to impart a flavour like that of turtle to soups and gravies.

ESSENES (sometimes called Hessenes), one of the three great sects into which the Jews were divided in the time of Christ. They are not mentioned in the New Testament; but it has been conjectured that they are alluded to in Matt. xix. 12, Col. ii. 18, 23. Many particulars concerning the customs and religious opinions of this sect are given by Josephus and Philo. Their statements differ in several points; but those of Josephus appear worthy of more credit, since he had in his youth passed some time among the Essenes. ('Antiquities of the Jews.')

The Essenes generally lived at a distance from large towns, in communities which bore a great resemblance to the monkish societies of later times. They employed themselves in agriculture, and had no slaves. They had all things in common, ate at a common table, and were exceedingly abstemious, never partaking of food before sunset. They were clothed in white garments, abstained from wine, and generally led a life of celibacy. They sent gifts to the Temple, but never offered any sacrifices there. They were divided into four classes, according to the time of their initiation. They admitted no one to their society till after a probation of three years; those who were admitted had to take solemn oaths that they would worship and serve God, and be just towards their fellow creatures; that they would love and speak the truth, and that they would never disclose the mysteries of the sect. The Essenes were exemplary in their religious duties, and were particularly distinguished by their rigid observance of the Sabbath-day. They believed in the immortality of the soul, but not in the resurrection of the body, and maintained the absolute predestination of all events; they held the Scriptures in the greatest reverence, but considered them as mystic writings, and explained them allegorically. They also appear to have possessed sacred books, which explained the peculiar doctrines and practices of their sect. (Philo, 'De Vita Contempl.,' vol. ii., p. 475.)

The origin of this sect is uncertain. Some writers consider them the same as the Assidians, or Chasidim, who are mentioned in 1 Macc. ii. 42; vii. 13. It would appear from the account of Pliny ('Nat. Hist.' v. 17) that their principal society was on the western side of the Dead Sea; and that from this society other smaller ones afterwards proceeded, and spread themselves over Palestine, Syria, and Egypt. Their numbers were never considerable: according to Philo and Josephus, there were only 4000 in Palestine.

The Essenes of Egypt were divided into two sects: the practical Essenes, whose manner of life was the same as the Essenes of Palestine; and the contemplative Essenes, who were also called Therapeutæ. Both sects maintained the same doctrines, but the latter was distinguished by a more rigid mode of life.

From a passage in Eusebius ('Hist. Eccles.' ii. 17), it has been argued by Bellarmine, Baronius, and other Roman Catholic writers, that the Therapeutæ were Christian monks formed into a society by St. Mark, who was the founder of the Christian church at Alexandria. But it is evident from the account of Philo, that the Therapeutæ were not Christians, but Jews.

It has been supposed, with considerable probability, that the early Christians derived many of their customs and opinions from the Essenes. Mr. Taylor, the editor of Calmet's 'Dictionary to the Bible,' gives many reasons for believing that John the Baptist belonged to this sect.

ESSENTIAL OILS, the odorous principles of plants, called also *Volatile Oils*, to distinguish them from the non-volatile or fixed oils. [FIXED OILS.] The present article will be devoted to a consideration of their sources, methods of production, uses, and general physical and chemical properties, together with an alphabetical list of those known up to the present time, including the specific characters of each, or references to other articles in this Cyclopædia where those characters are more fully detailed.

Sources.—Essential oils are not peculiar to any particular part of plants. They may reside in the root, stem, leaf, flower, fruit, or seed. They are generally contained in special cavities called receptacles of secretion. These cavitites are frequently larger than the surrounding cells, and indeed may often be seen with the naked eye. The dotted appearance of the rind of the orange and lemon, and of the leaves of the myrtle and St. John's wort [HYPERICUM, in NAT. HIST. DIV.] is due to the presence of numerous oil cavities. The cellular tissue forming the walls of the cavities is in many cases so compact that the plant may be dried and kept for several years without much of the oil being dissipated.

In nearly all instances the essential oils exist ready formed in plants. In the bitter almond and black pepper, however, contact with water is necessary to the production of the oil. Some other plants also, as milfoil, plantain, nettle, and centaury, which naturally have little or no odour, appear to undergo, when sprinkled with water, a kind of fermentation by which abundance of essential oil is produced. Finally, during the putrefaction of many vegetable matters, peculiar essential oils are generated.

Methods of Production.—In nearly all cases essential oils are obtained by a process of distillation. The plant, or that part of it from which the oil is to be extracted, is usually macerated for a few hours with four or five times its weight of water in a still furnished with a false bottom. Heat being applied, and the contents of the still brought into an active state of ebullition, the essential oil is volatilised along with the steam, and the vapours being condensed in any suitable way [CONDENSER] will, if the oil is present in sufficient quantity, separate into two portions, one a saturated solution of the oil in water, and the other a layer of the essential oil itself. The oil being collected by any suitable contrivance, the water should be occasionally returned to the still, and the distillation continued until the oil ceases to come over. The object of having a false bottom to the apparatus is to prevent portions of the plant from coming into immediate contact with the heated surface of the still, thus avoiding an unpleasant tarry taste and odour that would be communicated to the oil by volatile substances evolved from the overheated vegetable matter. The same end is arrived at by enclosing the ingredients acted upon in a bag, and so suspending the whole that it shall not touch any portion of the still. Even more advantageous is a plan now frequently adopted, of blowing steam from a perforated coil pipe through the materials to be acted upon, and condensing the vapours as before.

The water used in the above process dissolves a small portion of the oils, forming solutions that are used in medicine as vehicles for active preparations. Where it is required that these waters should be preserved, every trace of the excess of oil should be carefully removed; in some cases, redistillation of the water without the presence of the herb is beneficial.

If the water is not needed, the oil contained in it may be recovered by adding chloride of sodium to saturation, essential oils being but slightly soluble in the solution thus formed. Or the water may be agitated with ether, which will dissolve out the oil; the oil is then readily obtained by distilling off the ether.

In a few instances the essential oil of a plant cannot be extracted by distillation, on account of the injurious action of heat upon it, or because of its smallness in quantity. In that case, the substances to be operated upon may be placed in layers alternate with cloths saturated with an inodorous fixed oil, such as oil of poppies, and the cloths after a time submitted to strong pressure. The essential oil will then be found to have dissolved in the fixed oil, to which it will communicate its characteristic odour, and from which it may, if necessary, be separated by agitation with alcohol.

The oils of lemon and orange may be extracted by simple pressure of the rind of the fruit.

Uses.—The most extensive use of essential oils is in the fabrication of perfumes. Considerable quantities are also used in medicine, as topical or gastro-intestinal stimulants.

On account of the essential oil they contain, plants, or certain parts of them, are used to flavour liqueurs, confectionery, salads, savoury dishes, soups, &c.

Physical Properties.—The colour of essential oils is variable. The portions first obtained in the process of distillation are sometimes quite colourless, the later portions yellow or brown. These portions are however generally mixed together for commerce, so that essential oils are seldom seen without colour. Moreover nearly all the essential oils darken in colour on exposure to light and air. A few of them are green, and two or three of a blue colour. The essential oils have characteristic odours more powerful, but seldom as pleasant as that of the plants from which they are obtained. Their taste is hot and irritating. They have not the well-known unctuous feel that the fats and fixed oils possess when rubbed between the fingers, but on the contrary, are rough and harsh. They are nearly all lighter than water; a few however are heavier. The temperature at which the essential oils assume, on the one hand, the solid state, and on the other, the state of vapour, is very inconstant. This is explained by the fact that they are usually mixtures in variable proportions of a pure hydrocarbon, or *elæopten*, with an oxygenated hydrocarbon, or *stearopten*, the former commonly boiling at about 320° Fahr., the latter between 390° and 465°. Some of the essential oils are solid at temperatures below 60° Fahr., others require to be cooled several degrees below the freezing point of water before congelation occurs. The elæopten may generally be roughly separated from the stearopten by cooling the oil gradually. In the air the essential oils burn with a bright flame accompanied with much soot.

Chemical Properties.—Exposed to the air, essential oils absorb oxygen, and are slowly converted into resinous matters. During this process carbonic acid is sometimes evolved. Light favours the action. Essential oils are soluble in ether and alcohol, and to a slight extent in water. They are not soluble in caustic alkalies, and, with the exception of clove, pimento, and cinnamon-leaf oils, are not capable of saponification. They dissolve fixed oils, fats, and resins, with which they are not unfrequently adulterated; such fraud may, however, be easily detected by exposing a drop of the suspected oils on blotting-paper; if pure it will evaporate in a short time without leaving any stain; if mixed with either of the above substances, a greasy stain will be left on the paper. On passing the vapour of an essential oil over fused hydrate of potash, it is usually oxidised to an acid body that combines with the alkali, hydrogen gas being at the same time evolved. Chlorine, bromine, and iodine act upon and replace hydrogen in most of the essential oils. Nitric acid rapidly oxidises them.

Composition.—The ultimate chemical composition of essential oils is carbon, hydrogen, oxygen, and sometimes sulphur. In chemical and pharmaceutical treatises they will usually be found arranged in three divisions, according to their proximate composition:—1. Pure hydrocarbons; 2. oxidised hydrocarbons; 3. oils containing sulphur. 1. The pure hydrocarbons are nearly all isomeric and metameric, their molecule being represented by $C_{20}H_{16}$. Such are termed *camphogens* or *terebenes*, oil of turpentine being one of the members. Equal weights yield equal volumes of vapour; the specific gravity of them all is about ·860, and their boiling points range near 320° Fahr. They all absorb hydrochloric acid gas forming with it *artificial camphors* [TURPENTINE], and combine with water, forming solid bodies still more closely resembling camphor. Exposed to the air, they absorb oxygen, and are converted into resins. A few of the pure hydrocarbons have a composition differing from $C_{20}H_{16}$. 2. Oxidised hydrocarbons. Some of these are solid, forming the so-called *camphors* or *stearoptens* [CAMPHOR]. Others present the characters of an aldehyde, an alcohol, or an acid. The aldehydes, or hydrides as they are sometimes called, combine and form crystalline compounds with the bisulphites of the alkalies. 3. Oils containing sulphur. The members of this division are compounds of the radical ALLYL.

Tests for ascertaining the purity of the principal essential oils will be found described under the respective names of the latter. The necessary experiments, however, belong to the higher branches of pharmaceutical chemistry, and for this reason: that expensive oils are usually sophisticated with cheap ones, and from the great similarity that exists between many of them, both in physical and chemical properties, it necessarily follows that the detection of such adulterations is difficult. See 'Tests of the purity and adulteration of the volatile oils,' in 'Jahrb. für praktische Pharm., Juli. 1849,' and 'Pharmaceutical Journal,' vol. ix., old series, p. 575–580.

Essential oil of achillea, is obtained from the plant *yarrow*, or *milfoil*. [ACHILLEA, in NAT. HIST. DIV.] It is of a beautiful blue colour.

Essential oil of alliaria. The *alliaria officinalis* [ERYSIMUM, in NAT.

Hist. Div.] furnishes by distillation three essential oils. That from the root, before the leaves are developed, presents all the characters of sulphocyanide of allyl. [Mustard, Oil of.] That from the leaves is sulphide of allyl. [Garlic, Oil of.] The essential oil from the seed is sulphocyanide of allyl alone, or a mixture of that substance with sulphide of allyl.

Essential oil of almonds. [Benzoyl, Hydride of.]

Essential oil of allspice. See *Essential oil of pimento.*

Essential oil of amber. A product of the dry distillation of Amber. It is a mixture of several hydrocarbons analogous to oil of turpentine. Copal resin, and the resin of the dammar pine are frequently substituted for amber in the preparation of this oil.

Essential oil of anise is solid at temperatures below 50° Fahr. It contains one-fifth of its weight of a hydrocarbon analogous to oil of turpentine. The remaining four-fifths is a solid body of sp. gr. 1·014, melting point 65° Fahr., boiling point 432°. Its composition is $C_{20}H_{12}O_2$. [Anisic acid; Anisöin.] [Pimpinella, in Nat. Hist. Div.]

Essential oil of arnica. The root and flowers are said to yield two different oils. That from the flowers is blue.

Essential oil of artemisia. See *Essential oil of wormwood.*

Essential oil of asarabacca. This oil is composed of Asarone, and a liquid essential oil of yellow colour, acrid taste, and odour resembling valerian. [Asarum, in Nat. Hist. Div.]

Essential oil of asafœtida contains a compound of allyl, richer in sulphur than the sulphide of allyl. [Asafœtida.]

Essential oil of athamanta. See *Essential oil of peucedanum.*

Essential oil of balm, is of a pale yellow colour. Sp. gr. 0·975. [Melissa, in Nat. Hist. Div.]

Essential oil of balsam of Peru. This balsam owes its fragrance to Cinnamein. [Balsam *of Peru.*] [Myrospermum *Peruiferum,* in Nat. Hist. Div.]

Essential oil of basil. Sweet basil [Ocymum, in Nat. Hist. Div.] yields an oil containing a solid crystalline body resembling hydrate of oil of turpentine.

Essential oil of bays. See *Essential oil of laurel-berries.*

Essential oil of bergamot. [Bergamot, Essence of.]

Essential oil of birch is obtained by distillation of birch tar. It is a mixture of several oils; one of them is a hydrocarbon, $C_{20}H_{16}$. The odour of Russia leather is generally owing to this essential oil.

Essential oil of buchu is obtained by distillation with water from buchu leaves. Its colour is yellowish-brown. [Buchu.] [Diosma, in Nat. Hist. Div.]

Essential oil of cajuput. [Cajuput oil.]

Essential oil of camomile. Under this name there occur three different oils. First, that obtained from the true camomile plant. [Anthemis, in Nat. Hist. Div.] This is the oil that should be used in medicine, being the one indicated in the pharmacopœia. When first prepared it has a light green colour, but on exposure to air and light it becomes after a time yellow, and finally brown. It is composed of a hydrocarbon isomeric with oil of turpentine, and an oxidised portion, which Gerhardt ('Traité de Chimie organique,' tome ii. p. 445,) regards as the hydride of angelyl. Heated cautiously with caustic potash, the hydrocarbon is volatilised, and angelate of potash formed. A higher temperature decomposes the angelate of potash. [Angelic Acid.] A second oil of camomile is obtained from the wild camomile. [Matricaria, in Nat. Hist. Div.] It is prepared to a considerable extent in Germany, and is called in France essence of blue camomile. It is of a deep blue colour, and at common temperatures has the consistence of cream. The third oil is obtained from feverfew [Pyrethrum, in Nat. Hist. Div.], a plant closely allied to the camomile, and formerly named *matricaria;* hence the reason of its being confounded with oil of camomile. It is composed of a hydrocarbon and an oxygenised portion which hold in solution a camphor, differing but slightly from laurel camphor. [Camphor.]

Essential oil of candy-tuft, has the characters of sulphocyanide of allyl.

Essential oil of caoutchouc. [Caoutchin.]

Essential oil of capivi. Obtained by distilling balsam of capivi with water. [Balsam, *capivi.*] It is isomeric with oil of turpentine, but the hydrocarbon appears to be in a more condensed state, having the formula $C_{30}H_{24}$. Sp. gr. 878. Boiling point 500° Fahr.

Essential oil of cardamoms. [Cardamom, *essential oil of.*]

Essential oil of caraway. [Caraway, *oil of.*]

Essential oil of cascarilla is obtained by distillation with water. It has not been fully examined.

Essential oil of cassia, is, chemically, the same as *essential oil of cinnamon.*

Essential oil of cedarwood. [Cedarwood, *oil of.*]

Essential oil of cedrat. Another name for the *essential oil of citron-peel.*

Essential oil of celery is obtained from the seeds of the common celery. [Celery and Apium, in Nat. Hist. Div.] It contains a hydrocarbon ($C_{20}H_{16}$) that boils at 320° Fahr., and an oxygenised portion, the composition of which has not been satisfactorily established. The solution of the oil in spirit, made by digesting the seeds, is used as a flavouring essence.

Essential oil of chenopodium is used in the United States under the name of *wormseed oil.* It is obtained by distillation with water from the *Chenopodium anthelminticum.* It has a disagreeable odour, and yellow colour, sp. gr. ·98.

Essential oil of cherry laurel is very similar to essential of bitter almonds, containing hydrocyanic acid and hydride of benzoyl. [Benzoyl, *hydride of.*]

Essential oil of chervil. [Scandix and Anthriscus, Nat. Hist. Div.] It has not yet been chemically examined. [Chervil.]

Essential oil of cinchona. Trommsdorff obtained, by distilling 20 lbs. of cinchona bark with water, two grains of an essential oil having the odour of the bark and an acrid taste.

Essential oil of cinnamon. [Cinnamon, *oil of.*]

Essential oil of cinnamon-leaf. Obtained in Ceylon. The leaves are macerated in sea-water and the whole distilled. It is similar in composition and properties to oil of cloves. [Caryophyllic acid.]

Essential oil of citron-peel differs but slightly in composition and properties from essential oil of lemons. It has, however, an odour peculiar to itself, though the delicacy of the odour depends somewhat upon the part of the distillatory process at which it is taken. [Lemons, *oil of.*] [Citrus *medica,* in Nat. Hist. Div.]

Essential oil of citron-flowers is amber-coloured and slightly fragrant. Sixty pounds of flowers yield one ounce of oil.

Essential oil of citronelle. See *Essential oil of lemon-grass.*

Essential oil of cloves. [Caryophyllus; Caryophyllic Acid.]

Essential oil of coriander. Sp. gr. 0·872. Almost colourless. Possesses in a high degree the odour and taste of the plant. Boiling point about 302° Fahr. Its composition seems to be that of a hydrate of oil of turpentine ($C_{20}H_{16}+2HO$), but it needs farther examination. [Coriandrum *sativum,* in Nat. Hist. Div.]

Essential oil of cress. Yellow colour. Heavier than water. It contains sulphur, and is probably, like other essential oils from the natural order Cruciferæ, a compound of the radical Allyl. [Lepidium, in Nat. Hist. Div.]

Essential oil of cubebs. Cubebs [Piper *cubeba,* in Nat. Hist. Div.] contain 10·5 per cent. of a colourless essential oil having a camphrous taste and aromatic odour. It is generally more or less viscous. Sp. gr. 0·929. Boiling point a little below 500° Fahr. It contains the same hydrocarbon as essential oil of capivi. Cubebs also contain a solid camphor, a hydrate of the oil ($C_{30}H_{24}+2HO$). The camphor is also formed on rectifying oil of cubebs with water. It fuses at 154° Fahr., boils at 302°, is insoluble in water, but soluble in alcohol, ether, and the essential oils. [Cubebene.]

Essential oil of cummin. [Cymole; Cuminic acid; and Cuminum and Cyminum, in Nat. Hist. Div.]

Essential oil of dahlia. The tubercles of *Dahlia pinnata* furnish an essential oil, lighter than water. In the air it soon resinifies, and in water it after a time deposits crystals which appear to be benzoic acid.

Essential oil of dipterocarpus. Obtained on distilling *wood oil* with water. Wood oil is the resinous juice of several trees of the genus *Dipterocarpus.* [Dipterocarpus, in Nat. Hist. Div.] It contains about 60 per cent. of an essential oil of sp. gr. 0·928, boiling point 491° Fahr.

Essential oil of elder-flowers. [Sambucus, in Nat. Hist. Div.] Exists in very small quantity. Has a butyraceous consistence.

Essential oil of elemi, is contained in the resin [Amyridaceæ, in Nat. Hist. Div.] to the extent of from 7 to 14 per cent. Sp. gr. 0·850. Boiling point 345° Fahr. Its composition and vapour density are the same as oil of turpentine.

Essential oil of erysimum. See *Essential oil of alliaria.*

Essential oil of fennel differs in odour, but is composed of the same proximate constituents as *essential oil of aniseed.* [Fœniculum, in Nat. Hist. Div.]

Essential oil of galbanum. [Galbanum, in Nat. Hist. Div.] Obtained on distilling the gum-resin with water. Colourless, limpid, sp. gr. 0·912.

Essential oil of garlic. [Garlic, *Oil of.*]

Essential oil of gaultheria. See *Essential oil of wintergreen.* [Gaultheria, in Nat. Hist. Div.]

Essential oil of gentian may be procured from the root by distillation with water. It exists only in small quantity. It is lighter than water, and has the consistence of butter. [Gentiana *lutea,* Nat. Hist. Div.]

Essential oil of geranium. Several species of Pelargonium furnish a small quantity of essential oil, on distillation with water. This is true oil of geranium. For the commercial oil of geranium see *Essential oil of grass.* [Pelargonium, in Nat. Hist. Div.]

Essential oil of ginger. Sp. gr. 0·893. Boiling point 475° Fahr. A mixture of the hydrates of a hydrocarbon isomeric with oil of turpentine.

Essential oil of grain. The hydrated oxide of amyl. [Amyl.]

Essential oil of grass, or briefly *grass oil,* is the product of *Andropogon calamus aromaticus,* nat. ord. *gramineæ.* It is known in commerce as *oil of geranium,* is used in perfumery, and in the fabrication and falsification of attar of roses. It contains a hydrocarbon ($C_{20}H_{16}$), and an oxidised resinous portion.

Essential oil of hemlock has an acrid taste, and the peculiar odour of the plant. It is not poisonous. [Conium, in Nat. Hist. Div.]

Essential oil of hops contains the hydrocarbon, $C_{20}H_{16}$, along with valerole ($C_{12}H_{10}O_2$) [VALEROLE]. Exposed to the air it soon becomes resinified.

Essential oil of horsemint. [THYMENE; THYMOL.] [MENTHA *sylvestris*, in NAT. HIST. DIV.]

Essential oil of horse-radish. Sulpho-cyanide of allyl. [MUSTARD, OIL OF.] [COCHLEARIA *armoracia*, in NAT. HIST. DIV.]

Essential oil of hyssop has not been thoroughly examined. It is lighter than water.

Essential oil of india-rubber. [CAOUTCHIN.]

Essential oil of jasmin, generally obtained by placing jasmine flowers between layers of wool soaked in olive oil, and afterwards pressing out the oil. It may be separated from the fixed oil by agitation with spirit. At 32° Fahr. it deposits a crystalline stearopten.

Essential oil of juniper fruit. Boiling point 320° Fahr. It seems to be almost identical with oil of turpentine, but possesses less energetic lævo-rotation of a polarised ray of light. [JUNIPERUS *communis*, in NAT. HIST. DIV.]

Essential oil of laurel, or *laurel turpentine.* Isomeric with oil of turpentine. It is uncertain from what tree it is obtained. It is imported from Demerara. Sp. gr. at 56° Fahr. 0·8645.

Essential oil of laurel-berries, or *oil of sweet bay.* Obtained from the berries [LAURUS *nobilis*, in NAT. HIST. DIV.] by distillation with water. Pale yellow, transparent. Contains two isomeric oils ($C_{20}H_{16}O$). Sp. gr. of one 0·857, of the other 0·885.

Essential oil of lavender contains, in variable proportions, a crystalline matter resembling common camphor. The liquid portion appears to be isomeric with oil of turpentine. [LAVANDULA *angustifolia*, NAT. HIST. DIV.

Essential oil of lemon-grass, Essential oil of citronella, Essential oil of verbena. Obtained on distilling the grass *Andropogon citratum* with water. The plant is a native of India and Ceylon, but the oil is much used in this country for perfumery.

Essential oil of lemon-peel. [LEMON, *Essential oil of.*]

Essential oil of lemon-thyme. [THYMUS, in NAT. HIST. DIV.] Contains THYMENE and THYMOL.

Essential oil of lettuce. Lactucarium, the inspissated milky juice of the lettuce, furnishes on distillation with water an essential oil that has not been accurately examined.

Essential oil of mace. Obtained by distilling with water the arillus of the nutmeg. [MYRISTICA, in NAT. HIST. DIV.] It is at first colourless, but becomes yellow after a time. Its composition and use are similar to those of *Essential oil of nutmeg.*

Essential oil of male fern. On distilling the oil of male fern, obtained by digesting the plant in ether, a small quantity of a volatile oil is obtained.

Essential oil of marjoram. Sweet marjoram [ORIGANUM *marjorana*, in NAT. HIST. DIV.] contains an oil, differing in odour, but otherwise the same as that obtained from the common marjoram [ORIGANUM *vulgare*, NAT. HIST. DIV.] or origanum. One hundred pounds of the former herb yields about four ounces of oil, while the same weight of the latter herb yields double that quantity. This essential oil is composed of a hydrocarbon having the composition of oil of turpentine, and a hard colourless stearopten without odour and heavier than water.

Essential oil of masterwort, is a mixture of a terebene with an oxygenised portion. Distilled with water it gives an oil having the odour of essential oil of rosemary, and exactly the composition of oil of turpentine. [IMPERATORIA *ostruthium*, in NAT. HIST. DIV.]

Essential oil of meadow sweet. See *Essential oil of spiræa.*

Essential oil of milfoil. See *Essential oil of achillea.*

Essential oil of mustard. [MUSTARD, OIL OF.]

Essential oil of myrrh. Myrrh [BALSAMODENDRON, in NAT. HIST. DIV.] contains two and a half per cent. of an essential oil having the odour and taste of the resin. In contact with air it soon resinifies.

Essential oil of myrtle. Obtained in the usual way from the flowers and leaves of the plant, 100 lbs. yielding an average of about three ounces. [MYRTUS *communis*, in NAT. HIST. DIV.]

Essential oil of neroli. See *Essential oil of orange-flower.*

Essential oil of nutmeg. Obtained by distilling nutmegs [MYRISTICA, in NAT. HIST. DIV.] with water. It has an average sp. gr. of 0·92. It is colourless, and has the characteristic odour and taste of the nutmeg. It is composed of a hydrocarbon, lighter than water, and an oxygenised portion heavier than water. It contains in solution more or less of a stearopten, the melting point of which is 212° Fahr., and subliming point 234° Fahr.

Essential oil of olibanum. The gum resin olibanum [BOSWELLIA, in NAT. HIST. DIV.] yields about four per cent. of a colourless essential oil, having somewhat of the odour of oil of turpentine, but more agreeable. Its density is 0·866.

Essential oil of onion contains sulphur, and is probably identical with oil of garlic [GARLIC, OIL OF.]

Essential oil of orange-flower. Oil of neroli. Obtained by distilling the flowers with water. It is at first colourless but on exposure to light soon becomes red. It appears to be composed of two oils, one of which has an extremely pleasant odour, and is unusually soluble in water, the other unusually insoluble in water.

Essential oil of orange-leaf is obtained from the leaves of the bitter and sweet orange. It is met with in commerce under the name of *essence de petit grain.* Except in odour, it probably differs but little from the oil obtained from the rind of the fruit.

Essential oil of orange-peel has a peculiar odour, but in chemical composition, vapour-density, &c., it is identical with essential oil of lemon. [LEMON, *essential oil of*].

Essential oil of origanum. See *Essential oil of marjoram.*

Essential oil of parsley. Procured from the seeds [PETROSELINUM, in NAT. HIST. DIV.] It contains a hydrocarbon, isomeric with oil of turpentine, the boiling point of which is 320° Fahr., and a resinous portion containing oxygen.

Essential oil of partridge-berry. See *Essential oil of wintergreen.*

Essential oil of pennyroyal. This oil has a boiling point between 360° Fahr. and 370° Fahr. Its chemical composition seems to be the same as that of laurel camphor ($C_{20}H_{16}O_2$). It is present in the herb [MENTHA *Pulegium*, in NAT. HIST. DIV.] to the extent of about one per cent. Its sp. gr. is about 0·925.

Essential oil of pepper (*white or black*). Pepper owes its pungency to an essential oil having the same composition as oil of turpentine. Boiling point, 333° Fahr. Sp. gr., 0·864. Vapour-density, 4·73. The oil absorbs hydrochloric acid gas, and gives with it a crystalline camphor. [PIPER *nigrum*, in NAT. HIST. DIV.]

Essential oil of peppermint. [PEPPERMINT, *Essential oil of.*]

Essential oil of petit grain. See *Essential oil of orange-leaf.*

Essential oil of peucedanum. The fresh leaves [PEUCEDANUM *Oreoselinum*, in NAT. HIST. DIV.] contains an essential oil somewhat resembling that of juniper. Boiling point, 325° Fahr. Sp. gr., 0·843. It contains a hydrocarbon similar to oil of turpentine, and a small quantity of an oxidised portion.

Essential oil of pimento or *allspice.* [CARYOPHYLLIC ACID.]

Essential oil of pimpernel. The root of the common burnet [SANGUISORBA, in NAT. HIST. DIV.] furnishes a blue-coloured essential oil.

Essential oil of pine-apple is the butyrate of oxide of ethyl or butyric ether. [BUTYRIC ACID.]

Essential oil of poplar. Obtained on distilling with water the non-expanded flowers. [POPULUS *nigra*, in NAT. HIST. DIV.] It is colourless, of an agreeable odour, and heavier than water.

Essential oil of ptychotis ajowan [PTYCHOTIS, in NAT. HIST. DIV.] is obtained from the seeds, which contain between five and six per cent. It is composed of a hydrocarbon isomeric with oil of turpentine, and a stearopten that crystallises in beautiful oblique or rhombohedral crystals. On exposing the oil to the air in a shallow vessel these crystals may be obtained of considerable size. They are very similar, if not identical, with THYMOL. The Ptychotis is well known in India as an aromatic under the name of *ajowan* or *ajwain.*

Essential oil of radish. The seeds of the common garden radish [RAPHANUS *sativus*, in NAT. HIST. DIV.] furnish a colourless oil, heavier than water, and containing sulphur. It is probably the sulphide or the sulphocyanide of allyl.

Essential oil of ravensara. [EVODIA, in NAT. HIST. DIV.] Very similar to, and sometimes substituted for, oil of cloves.

Essential oil of rhodium. The root of Canary rosewood, *Genista canariensis*, yields by distillation this essential oil. It is of a light yellow colour, but by keeping becomes red; 100 lbs. of root yield about 1½ oz. of oil.

Essential oil of rosemary, prepared by distilling with water the tops of the plant. [ROSMARINUS, in NAT. HIST. DIV.] It is colourless, and has the characteristic taste and odour of the herb. Its sp. gr. is generally about 0·897, and boiling point 365° Fahr. It appears to be a mixture of hydrocarbon, oxygenised oil, and stearopten, in variable proportions.

Essential oil (*or attar*) *of roses.* [ATTAR OF ROSES.]

Essential oil of rue is capric or rutic aldehyde. [RUTIC ACID.]

Essential oil of saffron. Yellow, heavier than water. By exposure to air is converted into a solid crystalline substance. [CROCUS *sativus*, in NAT. HIST. DIV.]

Essential oil of sage. Obtained on distilling sage-leaves with water. It contains a hydrocarbon and an oxygenised portion. Nitric acid oxidises it to a crystalline body, having the odour and composition of laurel camphor. [SALVIA *officinalis*, in NAT. HIST. DIV.]

Essential oil of sandal-wood is procured by distilling the wood [PTEROCARPUS *santalinus*, in NAT. HIST. DIV.] with water. The yield is generally about two per cent. It is sometimes substituted for oil of rhodium and attar of roses.

Essential oil of sarsaparilla. In an experiment described by Pereira ('Materia Medica,' p. 1168), 140 lbs. of sarsaparilla root distilled with water yielded a few drops of an essential oil having the odour and acrid taste of the root, soluble in alcohol, and heavier than water.

Essential oil of sassafras. The wood [SASSAFRAS, in NAT. HIST. DIV.] yields on distillation with water a light yellow oil, of acrid taste and characteristic odour. Sp. gr. 1·094. On exposure to intense cold, large quantities of crystals are obtained from it. These have the formula $C_{20}H_{10}O_4$. Bromine acts violently on oil of sassafras, giving rise to a crystalline substitution product having the formula $C_{10}(H_2Br_8)O_4$.

Essential oil of savin. The fresh tops or berries [JUNIPERUS *sabina*, in NAT. HIST. DIV.] yield an essential oil of sp. gr. 0·915. It has the same composition and boiling point as oil of turpentine ($C_{20}H_{16}$).

Essential oil of scurvy-grass contains the sulphocyanide of allyl. [Mustard, Oil of.] [Cochlearia *officinalis*, in Nat. Hist. Div.]

Essential oil of senna. Exists in the leaves in rather small quantity. Extracted by distillation with water. It has a nauseous odour and taste. [Cassia, in Nat. Hist. Div.] [Senna.]

Essential oil of spearmint. The herb [Mentha *viridis*, in Nat. Hist. Div.] furnishes not more than about two-tenths per cent. of an oil of sp. gr. 0·914. Its colour is pale yellow, deepening by age. It is nearly identical with oil of peppermint. [Peppermint, *Essential oil of*.]

Essential oil of spike. Foreign oil of lavender. [Lavandula *spica*, in Nat. Hist. Div.] It is chemically the same as the true oil of lavender (from *Lavandula vera*), but has a darker green colour and less grateful odour.

Essential oil of spikenard is another name for the so-called essential oil of geranium. See *Essential oil of grass.*

Essential oil of spiræa. The flowers of meadow-sweet (Reine des Prés), [Spiræa *ulmaria*, in Nat. Hist. Div.] yield on distillation with water an essential oil containing a small quantity of a hydrocarbon isomeric with oil of turpentine, but consisting chiefly of an oxygenised body ($C_{14}H_6O_4$) that is identical with hydride of salicyl ($C_{14}H_5O_4,H$). [Salicyl, Hydride of]. Its specific gravity is 1·173, vapour-density 4·276, boiling-point 360° Fahr.

Essential oil of star-anise differs in odour, but is otherwise similar to that of the common anise. See *Essential oil of aniseed.* [Illicium *anisatum*, in Nat. Hist. Div.]

Essential oil of starch. According to M. Payen ('Pharmaceutical Journal,' vol. vii. O. S. p. 37) an essential oil pre-exists in the concentric layers of the grains of starch. About one ten-thousanth part of the starch is a yellowish liquid oil, having the characteristic smell of the starch in a high degree. Starch contains in addition a concrete oily matter less volatile than water. The fluid oil is lighter than water, and has a higher vapour-tension.

Essential oil of sweet bay. See *Essential oil of laurel-berries.*

Essential oil of sweet flag. The rhizome of the *Acorus calamus* [Acorus, in Nat. Hist. Div.] contains one per cent. of an essential oil principally composed of a hydrocarbon, but also containing an oxygenised portion. Neither have been thoroughly examined.

Essential oil of tansy is of a pale or golden yellow colour, sometimes green. It has a strong nauseous odour, and acrid bitter taste. Sp. gr. 0·931. [Tanacetum, in Nat. Hist. Div.]

Essential oil of tarragon. The tarragon [Artemisia *dracunculus*, in Nat. Hist. Div.] furnishes an essential oil closely allied to *essential oil of aniseed.*

Essential oil of tea. Common tea [Thea, in Nat. Hist. Div.] furnishes by distillation with water an oil lighter than water, and having in a high degree the characteristic smell of the tea. The odour of it excites giddiness to such an extent, that it may be said to be powerfully poisonous. The major part present in the fresh leaves is dissipated in the drying process they undergo.

Essential oil of templinum is the name given to an essential oil obtained in Hungary by distilling with water the young branches of the dwarf or mountain pine [Pinus *pumilio*, in Nat. Hist. Div.].

Essential oil of thyme. By distilling with water common garden thyme. [Thymus *vulgaris*, in Nat. Hist. Div.]. It contains a hydrocarbon, and an oxygenised portion. [Thymene; Thymol.]

Essential oil of tobacco. By the dry distillation of tobacco, as for instance in the process of cigar or pipe smoking, an essential oil is produced that is one of the most violent of known poisons. By the distillation of tobacco leaves with water, a solid volatile oil is obtained having odour and taste characteristic of the drug. [Nicotiana, in Nat. Hist. Div].

Essential oil of tolu, obtained by distillation, is mainly a hydrocarbon *tolene*. It absorbs oxygen when exposed to the air, and becomes resinified. [Myrospermum *toluiferum*, in Nat. Hist. Div.] [Balsams.]

Essential oil of turpentine. [Turpentine.]

Essential oil of valerian. The root [Valeriana *officinalis*, in Nat. Hist. Div.] contains an essential oil of powerful odour. It consists of a hydrocarbon ($C_{20}H_{16}$) isomeric with oil of turpentine, and identical with bornéène [Camphor], and of an oxygenised portion called *valerol* ($C_{12}H_{10}O_2$). [Valerol.]

Essential oil of verbena. See *Essential oil of lemon-grass.*

Essential oil of vittie vayr or *vetiver* may be obtained from the fibrous roots sold by perfumers under the name of vittie vayr. On account of the essential oil contained in them, they are much used in India for scenting apartments, and for preserving clothing from the attacks of insects. They are the roots of a grass (*Andropogon muricatus*) closely allied to the English sweet vernal grass. The oil contains a hydrocarbon ($C_{20}H_{16}$) and an oxygenised portion. It is lighter than water.

Essential oil of wintergreen may be extracted from the flowers of the wintergreen [Gaultheria *procumbens*, in Nat. Hist. Div.] by maceration in alcohol, or in ether. Nine-tenths of it are *gaultheric acid* ($C_{16}H_8O_6$) the salicylate of methyl ($C_{14}H_5O_5C_2H_3O$) or hydrate of methyl-salicyl ($HO,C_{14}H_4(C_2H_3)O_5$). The other tenth is a hydrocarbon, isomeric with oil of turpentine, called *gaultherilene.* The latter boils at 320° Fahr., vapour density 4·92.

Essential oil of winter's bark contains a pale yellow oil, lighter than water, and having a hot acrid taste. [Winteraceæ, *Drimys wintera*, in Nat. Hist. Div.]

Essential oil of wormseed. See *Essential oil of chenopodium.*

Essential oil of wormwood. The herb [Artemisia *absinthium*, in Nat. Hist. Div.] yields an oil that, when pure, has the composition ($C_{20}H_{16}O_2$) sp. gr. 0·973, vapour-density 5·3. It is evidently isomeric with laurel camphor. [Camphor.]

Essential oil of xanthoxylum. The Japanese pepper [Xanthoxylum *piperitum*, in Nat. Hist. Div.] contains a hydrocarbon ($C_{20}H_{16}$) *xanthoxylene* to which the odour of the pepper is due, and a stearopten ($C_{40}H_6O_4$) called *xanthoxylin.*

Essential oil of zedoary. The tubers of the broad-leaved turmeric [Curcuma *zedoaria*, in Nat. Hist. Div.] yield a yellow, somewhat opaque oil having a camphorous odour and taste. It is composed of two oils, one lighter, the other heavier than water.

ESSOIGNS, Latin *Essonium*, French *Essoigne* (apparently from the Latin *Exonerare*), is the allegation of an excuse for non-appearance by a person summoned to answer an action at law, or to perform service at a court baron. There were various admitted causes of such excuse, such as illness, falling among thieves, floods, &c. And a party might essoign himself three times by sending a substitute to explain the reasons for his non-appearances. The first return day in every term was, properly speaking, the first day of the term; and on that day the courts formerly sat to take essoigns or excuses from such as did not appear to the summons or the writ; wherefore it was called the essoign day. But essoigns have become almost unknown in practice. They were confined to real and mixed actions. Of the former only three now remain, and these three are rarely resorted to, so that the learning relating to essoigns is almost lost.

ESTATE, in Law, signifies that title or interest which a man has in lands, tenements, hereditaments, or other effects. It is either real, comprising lands, tenements, and hereditaments held or enjoyed for an estate of freehold; or personal, comprising interests for terms of years in lands, tenements, and hereditaments, and property of every other description. Personal estate [Chattels] goes to the executors, and is primarily liable for payment of debts.

Real estate may be considered under three heads:—(1) the quantity of estate, *i. e.*, the amount of interest in the owner; (2) the time when that interest is to commence; and (3) the quality of estate, or the mode in which it is to be enjoyed.

1. All real estates not being of copyhold tenure [Copyhold], or what are called customary freeholds, are either of freehold or less than freehold. The former may be divided into two kinds; freeholds of inheritance, and freeholds not of inheritance. Freeholds of inheritance admit of a further subdivision, into inheritances absolute, called fee simple, and inheritances limited, called qualified or base fees, and fees conditional. A freehold of inheritance absolute of fee simple is the largest estate which the law allows to a subject; the owner may freely dispose of it to whom he pleases in his lifetime by deed or by will, and if he dies without making any disposition, it descends to such of his kindred as the law marks out as his heir.

A qualified or base fee has some qualification or limit annexed, which may determine the estate, as in the instance of a grant to A and his heirs *tenants of the manor of Dale.* Whenever A or his heirs cease to be tenants of that manor, their estate is entirely determined, though during its continuance the proprietor has the same rights and privileges as if he were absolute tenant in fee simple.

A conditional fee at common law was a fee restrained to some particular heirs exclusive of others, as to a man and the heirs male of his body, by which limitation his lineal heirs female and collaterals were excluded; and this is the origin of estates tail. It was held that if the donee, in the case supposed, had no heirs male of his body, or if, after a male child was born, no alienation were made, the land should revert to the donor on the failure of heirs male of the donee's body: in fact for all purposes of alienation it was a fee simple, on condition that the donee had male issue; for it is a rule of law, that when any condition is performed it is thenceforth entirely gone, and the thing to which it was annexed becomes absolutely and wholly unconditional. The nobility, however, being anxious to preserve their estates in their own families, procured the Stat. Westm. the Second, 13 Ed. I., c. 1, commonly called the Statute de Donis Conditionalibus, to be made, which enacted that the will of the donor should be observed, and that the land should go to the heirs specified, if there were any, or if none, should revert to the donor. Thus the donor acquired an estate in reversion, which could only be allowed, consistently with the nature of estates in reversion, by considering the conditional fee to be changed into a limited, or, as it is called in technical language, a particular estate. This kind of estate was called an estate *tail*, from the word *talliare*, to cut, being as it were a portion of the whole fee. Means were soon however discovered by the ingenuity of the lawyers to enable the donee and his heirs of the specified description to cut off the entail, as it was called. [Conveyance; Fine; Recovery.]

A freehold, not of inheritance, is an estate which the owner has for his own life only, or the life of some other person, or until the happening of some uncertain event. The following are instances:—A gift to A until B returns from Rome; but if the gift had been to A and his heirs until B returns from Rome, the estate would have been a qualified or base fee; and if B had died without returning from Rome, would have become a fee simple absolute. Some freeholds not of inheritance, arise from operation of law, as tenant in tail after possibility of issue extinct, which is where an estate is limited to A and the heirs of his body to be begotten on the body of B his wife, which is called an estate tail special (as distinguished from an estate tail general, *i. e.* to A and the heirs of his body, without specifying the woman from whom they must spring). If B dies without children, A is no longer tenant in tail, but tenant in tail after possibility of issue extinct, and is regarded by the law, as to the duration of his estate, as simple tenant for life. As to tenant by courtesy and tenant in dower, see COURTESY and DOWER.

Of estates less than freehold there are three kinds—estates for years, at will, and by sufferance. An estate for years (which includes an estate from year to year) is personal property, and, like other chattels [CHATTELS], upon the death of the owner, without having disposed of it in his lifetime, devolves upon his executors or administrators. An estate at will arises where a man lets lands to another expressly at the will of both parties or without limiting any certain estate; either party may put an end to the tenancy, though, for the sake of general convenience, the courts strive to construe them as tenancies from year to year, for the purpose of rendering a six months' notice necessary to their determination. An estate by sufferance arises where a tenant, who has entered by lawful title, continues in possession after his intrest has determined: this estate may be put an end to at any time by the lawful owner, though, after acceptance of rent, the law would consider it as a tenancy from year to year, as in the case of a tenancy at will.

Neither of these two last estates confers any power of alienation. All these estates, real and personal, freehold or less than freehold, freeholds of inheritance or not of inheritance, may become subject to another qualification, and be called estates upon condition, being such whose existence depends upon the happening or not happening of some uncertain event whereby the estate may be either originally created or enlarged or finally defeated. [CONDITION; MORTGAGE.]

2. Estates are either in possession or in expectancy.

The former kind of estate requires no explanation here. The latter, involving some of the nicest and most abstruse learning in English law, are divided into estates in remainder and reversion, and by executory devise or bequest; and again, remainders are divided into estates in remainder vested or contingent. [REMAINDER; REVERSION.] An executory devise or bequest is such a limitation of a future estate or interest in lands or chattels as the law admits in the case of a will, though contrary to the rules of limitation in conveyances at common law. It is only an indulgence allowed to a man's last will and testament, where otherwise the words of the will would be void; for wherever a future interest is so limited by a will as to fall within the rules laid down for the limitation of contingent remainders, such an interest is not an executory devise, but a contingent remainder. [WILL.]

3. Estates may be enjoyed in four ways; in severalty, in joint tenancy, in coparcenary, and in common.

An estate in severalty is when one tenant holds it in his own right without any other person being joined with him.

An estate in joint tenancy is when an estate is granted to two or more persons at the same time, in which case the law construes them to be joint tenants, unless the words of the grant expressly exclude such construction; they have unity of interest, of title, of time of vesting, and of possession, and upon the decease of one, his whole interest, unless disposed of by him in his lifetime, remains to the survivor or survivors.

An estate in coparcenary is when an estate of inheritance descends from the ancestor to two or more persons, who are called parceners, and amongst parceners there is no survivorship.

An estate in common is when two or more persons hold property, by distinct titles and for different interests, but by unity of possession.

All these three last-mentioned modes of joint and undivided possession may be put an end to by the parties interested, either by prescribed modes of conveyance or by partition. [PARTITION.]

Estates are also legal or equitable. It is a legal estate when the owner is in the actual seisin or possession, and also entitled to the beneficial interest himself or in trust for some other person. An equitable estate is when some other person, and not the person who is the actual and legal owner, is entitled to the beneficial interest of the property of which that other is in possession. The power of the beneficial owner over his equitable estate is as complete as if he were possessed of the legal estate. [TRUST; EQUITY.]

ESTHER, The Book of, a canonical and historical book of the Old Testament, placed after that of Nehemiah, but coming chronologically between the 6th and 7th chapters of Ezra. It is thus denominated from the Persian name of the Jewish woman, Hadassah, whose history it relates. She was an orphan niece and adopted daughter of Mordecai, from a Benjamite family of the Babylonian captives of Nebuchadnezzar (ii. 5-7). The scene of the narration is in the city Shusan, or Susa, now Sus (not Shuster, as stated by Dr. Adam Clarke—see 'Trans. Geog. Soc.,' vol. iii.), which, throughout the book, is in English mistranslated Shushan the *palace*, though, in the Septuagint version, it is rightly ἐν Σοῦσοις τῇ πόλει, that is, "in Susa the city." Augustine, Epiphanius, and Isidore, supposed the author to have been Ezra. Eusebius assigns a later date. Some writers have attributed it to the high-priest Joachim; others believe it to have been composed by the Jewish synagogue, to whom Esther and Mordecai wrote (ix. 20-29); but by the greater number Mordecai himself is thought to be the author, and Elias Levita, in his 'Mass. Hamum,' asserts this to be a fact unquestionable. St. Hieronymus and several other fathers regarded this book as wholly uncanonical, because the name of God or religion is not once mentioned or alluded to, and they have been followed by some modern writers, as Cajetan and De Lyra; but the Council of Trent pronounced it to be wholly canonical; and while the Protestant churches admit into the canon only what is found in the Hebrew copies, that is, as far as to the end of the third verse of chap. x., the Greek and Roman churches use as canonical the Greek version and Latin Vulgate, which contain each ten more verses of chap. x. and six additional chapters. By the Jews the book has been always considered as one of the most precious of their sacred scriptures, and as a perfectly authentic history of real events which took place about B.C. 519. They call it מגילה, Megilah, that is, *The* Volume, and hold it in the highest estimation; believing that whatever destruction may happen to the other scriptures, Esther and the Pentateuch will always be preserved by a particular Providence. Copies exist in the Hebrew, Syriac, Chaldaic, Greek, and Latin, each of which widely differs from the others, and all, especially the Greek and Chaldaic, are greatly different from the Hebrew. The Chaldaic text contains five times more than the Hebrew, and a notice of the various readings would fill a large volume. (See the London Polyglot Bible.) Commentators differ much in determining to which of the Persian and Median kings belongs the name of Ahasuerus, whose kingdom extended from India to Ethiopia over 127 provinces (i. 1). Some suppose him to be Darius Hystaspes, Scaliger and Jahn say Xerxes. By Capellus he is identified with Ochus, and by Archbishop Usher with Darius the son of Hystaspes. Dean Prideaux and Dr. Adam Clarke with greater probability take him to be Artaxerxes, who received the cognomen of Longimanus, or Longhanded. To the objections that have been made that the book is a fiction, Eichhorn has satisfactorily replied, proving that it rests upon an historical basis; and as to its not being included in some lists of the canonical books of the Hebrews, that may have arisen from its having been joined to some other book, as that of Ruth was to Judges, Nehemiah to Ezra, and Lamentations to Jeremiah. The author of the second book of Maccabees recognises its authority by fixing the day for the deliverance of the Jews from the Syrian on the day before Mardocheus' day; and Josephus says that the feast of Esther was celebrated by the Jews throughout the habitable world.

This signal revenge of Haman's intended destruction of the Jews in Persia has ever since been commemorated (ix. 21-28) on the 14th and 15th days of the month Adar, in the Jewish 'Feast of Purim,' that is, in Persian, *the lots*; with reference to those which, on this occasion, were cast before Haman (ch. iii. 7; ix. 26). It is here worthy of remark, that the word which in the authorised version is repeatedly translated *gallows*, should properly be *cross* or tree. Hence it was that in the first ages of Christianity, the Jews, when celebrating this feast of Purim, were accused of deriding the Christian crucifixion, in abusing and setting fire to an effigy of Haman affixed to a lofty wooden *cross*; a custom which, on this account, was abolished in the Roman Empire by the decrees of Justinian and Theodosius. That the names of God or Lord are not mentioned in the book, is certainly a singular fact, but the whole tendency of the book is pious; it shows the continued action of the Divine Providence in preserving a race from whom the Messiah was to spring; and, though not mentioned, the presence and the intervention of God is throughout made to be felt.

ESTOPPEL, an impediment or bar to a right of action, arising from a man's own act, or the act of some person through whom he claims. There are three kinds of estoppel. 1. *By matter of record*, as letters patent, pleading, &c. Thus in an action against a patentee by his assignee, the patentee is estopped from pleading that the patent is invalid.

2. *By matter of writing*, as by deed, &c., parties and privies are estopped from alleging any thing contrary to the deed.

3. *By matter in pais* (in the country), that is, transactions between the parties not evidenced by record or writing, as livery, entry, acceptance of rent, &c. Thus after acceptance of rent a landlord cannot treat his lessee as a trespasser.

ESTOVERS. Spelman, in his Law Glossary, says that this word is derived from the French *étoffe*, and that from *étoffer*, which is to supply with necessaries, and is of the same signification as the Saxon word *bote*. In legal phraseology it is the liberty which the owner of an estate for life as well as a tenant for years (in the absence of any stipulation to the contrary) possesses of taking a reasonable and necessary supply of wood from the estate for the use or furniture of his house or farm, and this, according to the use to which it was applied, was either called house bote, plough bote, cart bote, or hedge bote. *House bote* is a sufficient allowance of wood to build or repair the house, or to burn in it, which latter is also sometimes called *fire-bote*; *plough-bote* or *cart bote* is the wood employed in the making or repairing all instruments of husbandry, as carts and ploughs, harrows, rakes, &c.; *hedge bote* or *hay bote* for repairing hedges, fences, pales, stiles, and gates, and to secure inclosures.

If a tenant takes more than is needful for these purposes he may be punished for waste, as if he cuts down wood to burn when he has sufficient dead wood upon the estate; and a tenant, although he may cut down and take sufficient wood to repair pales and fences as he found them, cannot do so to make new ones.

A rector may also cut down wood for the repair of his parsonage-house or the chancel, and even for any old pews which belong to the rectory; and, like other tenants for life, he is entitled to estovers for repairing the barns and out-houses belonging to the parsonage.

Bracton uses the word estovers in a different sense, viz., as the sustenance, which a man committed for a felony is to have out of his lands and goods for himself and family during his imprisonment; it also occurs in the statute 6 Ed. I. c. 3, as an allowance of meat or cloth; but the more common and usual signification by which it is known to lawyers has been already stated. (Woodfall, *Landlord and Tenant ;* Comyn.)

ESTRA'NGELO, or ESTRANGHELO, is the name of the most ancient of the three kinds of characters used in writing the Aramæan or Syriac language. The alphabet so called, of which there is a copy in the Prolegomena to Walton's 'Polyglot,' p. 11, is distinguished by the stiffness and angular forms of the letters from that found in all printed Syriac books, which is denominated facitto (that is, simple), or sertto (linear). A character nearly resembling the Estranghelo is stated to be still commonly used in writing by the Nestorians and some of the Melchitæ. It is believed to have been originally common to all the nations or tribes speaking any Chaldaic dialect. The Syriac grammarians also enumerate a third alphabet, which they designate the eefifo (meaning the duplicated), or the messttariono (the split); but this is merely an alphabet of what we should call open letters, used for ornamental purposes.

See 'Grammatica Syriaca, sive Chaldaica, Georgii Michaelis Amiræ Edeniensis è Libano,' 4to, Rom. 1596, cap. i., where copies of all the three alphabets are given.

ESTRAY, any valuable tame animal found wandering at large within any manor or lordship, and whose owner is unknown. Having been impounded, and proclaimed in the church and the two nearest market-towns on a market-day, it becomes, if not claimed in a year and a day, the absolute property of the king, as lord paramount of the soil, though generally the lord of the manor or liberty is the special grantee of the crown. Animals upon which the law sets no value, as a dog or a cat, or such as are of a wild nature, as a fox or a wolf, cannot be taken as estrays. Swans may be taken as estrays, but no other fowl. The king or the lord does not acquire the absolute property in the estray until the full expiration of the year and a day, which runs from the first proclamation, and not from the seizure; therefore if it escape before the time to another manor he cannot reclaim it.

The king or the lord is bound to take care of the estray, and find it in provision; he must not use it, but is liable to an action for so doing, though he may milk a cow or the like, for that tends to the preservation of the animal, and is necessary. The owner on the other hand, if he claims within the time allowed, must pay the charges of finding, keeping, and proclaiming the estray.

It may be observed, that if any person not being entitled to estrays, finds and takes care of another's property, the owner may recover it or its value without being obliged to pay for the expenses incurred in keeping it.

ESTREAT, from the Latin word *extractum*, is a true copy or note on the rolls of a court of some original writing or record, especially of fines and amerciaments which are to be levied by a bailiff or other officer. In all cases of felony or misdemeanor where persons bound by recognisance either to appear themselves, or for the attendance of any witness on trials of felonies or misdemeanors, neglect to do so, the recognisance becomes forfeited; an officer of the court, whose duty it is at the end of the assize or session, prepares a list of the defaulters, and when the same has been approved by the judge presiding, the fine or forfeiture mentioned in the recognisance is said to be estreated or certified into the Exchequer, and process is awarded for its recovery.

These fines, when levied, are paid into the Treasury, or the lords of the Treasury may, if they think fit previously to the issuing of the process, stay the execution and remit the fine.

The barons of the Exchequer were also empowered by a standing writ of privy seal to discharge, mitigate, or compound forfeitures estreated into the Exchequer from other courts; and by the 4th Geo. III. c. 10, they are also authorised, upon affidavit and petition, to discharge estreated recognisances and forfeitures, except those incurred before justices of the peace.

ETCHING. [ENGRAVING.]

ETESIAN WINDS. [WINDS.]

ETHAL, a substance separated from spermaceti by Chevreul. It is a solid, fusible at nearly the same point as spermaceti, and on cooling crystallises in plates. It is insoluble in water; but in alcohol at 150° Fahr. it is much more soluble than spermaceti. Ethal is susceptible of union with various bases, with which it forms salts or soaps. [CETYL, *Hydrate of cetyl*.]

ETHALIC ACID. [PALMITIC ACID.]

ETHALONE. [PALMITONE.]

ETHANIM, אֵתָנִים, like Zif and Bul, is an ancient Hebrew name of the month called now Tisri, the first month of the civil year. These months are nowhere named in the Bible, except in two chapters of the first book of Kings: Ethanim is in ch. viii. v. 2, and it is there called the seventh month of the year, which place it held in the calendar until the middle of the 4th century A.D., when the commencement of the year was altered from spring to autumn. According to some Jewish authorities this change was made with a view to restoring an original form of the calendar said to have been in use from the creation of the world, which was believed to have occurred at the autumnal equinox; and this appears to be the view of the Chaldee paraphrast of the verse above mentioned, who renders it "In the month which they [anciently] called the first month, and which is now the seventh." Buxtorf, who quotes this passage from the Targum, says that the old usage ceased after the Exodus.

The word Ethanim appears to be derived from אֵיתָן strong, rough. It is also said to signify 'running streams.' There is no evidence of its having been used since the days of Nehemiah, though the name Tisri, now in use, which must signify 'a beginning,' from the root שְׁרָה, could hardly have been adopted before the alteration of the calendar, many centuries after Nehemiah; and even if we stretch our confidence in the tradition so far as to admit of a more ancient calendar in which the year began in autumn, a word which implies 'beginning' could hardly have continued in use for the appellation of a month occurring in the middle of the year.

ETHER, *Medical Properties of.* It is intended here only to notice the medical uses of ethers long known, with a few of those more recently introduced. The first to be treated of, after giving a brief general view of their modes of action on the human system, is sulphuric ether, which is always understood to be the one indicated when the term ether is employed absolutely. The German chemists and therapeutists designate them *naphthæ*, a term liable to cause them to be confounded with *bitumens*. Ethers present the most perfect examples of volatile stimulants, being unequalled for rapidity of action, when immediate aid must be imparted to the muscular system, especially the involuntary muscles, by augmenting the nervous power, and by quickening its development. Whether they effect this by a direct impression on the nerves, or by previous absorption into the circulation, it is very difficult to determine, since most of them are absorbed so rapidly as almost instantly to mix with the circulating mass. They bear the greatest resemblance to alcoholic stimulants; but are distinguished by more instantaneous effects. These however are more transient, and a more frequent repetition of the dose is therefore required. Fatal results are less likely to follow from large doses of ether than of alcohol, a fact which can only be accounted for by the excess being more speedily thrown out of the system, especially by pulmonary and in some degree by cutaneous exhalations; for the more highly carbonised constitution of ether would lead us to expect a contrary result. This furnishes the proper guide for the treatment of cases of poisoning by them, namely, placing the patient where he may respire as pure air as possible, and in the light, carrying on artificial respiration if needful, occasionally dashing cold water on the face and temples, and cautiously using venesection or cupping. Transmitting a galvanic current of a moderate force along the eighth pair of nerves is often beneficial. Perseverance in the use of these means for hours is frequently successful. Sulphuric ether is the most powerful of etherial preparations, and therefore of diffusable stimulants. It is distinguished from the others likewise by having less secondary effects upon the system. Hence it is more employed for its primary effects than for both primary and secondary effects. It is of a peculiar, strong, penetrating, rather agreeable odour; the taste is at first cooling, afterwards hot, leaving a feeling of dryness in the mouth and throat. Its volatility is very great, and though it does not excite redness of the mucous membrane of the stomach in a moderate dose, yet being quickly changed into vapour by the heat of that organ, it causes contraction of its muscular coat, and expulsion of gas, thus acting as a carminative, or it produces most painful distension if that viscus be not powerful enough to resist its local action, and is followed by slight cerebral excitement, and even a feeling similar to intoxication may be experienced, which however soon passes off, without leaving any marked depression; though a disposition to sleep, and sometimes tendency to perspiration, are the ultimate consequences. The lungs are the common channel by which it is eliminated; this ether having less influence on the kidneys or skin than the other sorts. If spasm, irregular action, or debility of the organs of circulation, respiration, or digestion, existed previous to its administration, these generally disappear speedily, or are alleviated by its use. Hence it ranks as an antispasmodic of the highest kind. It is therefore resorted to in all cases of imminent danger, from difficulty of breathing, colic, flatulence, and deep depression, such as occurs in cholera Asiatica, or the later stages of fever. In relieving paroxysms of asthma it is unrivalled, and may be inhaled along with the vapour of warm water, or by being dropped on a portion of sugar held between the teeth. Like all stimulants, habit diminishes its influence on the system, so that the dose requires to be greatly increased. So much as two ounces have been taken by an adult in twenty-four hours. This is hazardous, and the necessity for it may be diminished by alternating sulphuric ether with some of the other ethers, which, though little known or used in this country, are found very effectual by the German, French, and American practitioners. An increase of our etherial preparations would be a valuable accession to our curative agents. Economy and physiology alike recommend the proceeding. The great solvent power of sulphuric ether renders it an eligible menstruum for the administration of a variety of articles; by these its own powers are heightened. It has also been attempted to take advantage of its power in this respect, by employing it in cases of biliary calculi, not merely to alleviate the agonising pain, but from a belief that it would dissolve the calculus, and so lessen its bulk. Oil of turpentine is a good addition. It has also been recommended against tape-worm, from a notion that the volatised ether would greatly annoy the worm, and allow it to be easily removed by a dose of castor oil or other purgative. This is not free from inconvenience and even danger to the feeble persons who are infested with the tape-worm. The antispasmodic powers of ether are much increased by adding tincture of opium, or a solution of the hydrochlorate of morphia. This combination furnishes the most effectual means of warding off a paroxysm of hysteria or epilepsy, if administered promptly. This is an object of great moment, as every fit, if allowed to take place, predisposes to a recurrence of them. Externally, ether is applied to the temples to relieve nervous headaches; and also over hernial tumours, in order that by the cold consequent on its evaporation the hernia may contract and be reduced: a portion of thin oiled silk should lie interposed between the ether and the skin.

Sulphuric ether is rarely found in shops perfectly pure. The casual or intentional adulterations interfere more with its chemical properties as a solvent of various substances than with its medicinal powers. Time however resolves it, particularly if kept in the light, into acetic acid and alcohol. It ought therefore to be recently prepared, and preserved in an obscure place. The Spirit of sulphuric ether is only a weaker form, with some etherial oil, of the pure ether.

Nitric or hyponitrous ether is never employed pure in medicine, but only as the spirit of nitric ether. This has considerable resemblance to the sulphuric ether, but is more miscible with water. It likewise has more marked secondary effects, especially on the kidneys and skin. Hence it is much employed as a diuretic. Its impression on the organ of taste is aromatic, sweet, and cooling, and it is known familiarly as the Sweet Spirit of Nitre. Its restorative action is neither so quick nor so certain as that of sulphuric ether; but where dropsical effusions co-exist with disease of the heart, it merits the preference. It is charged with uncertainty as a diuretic, less perhaps from its own nature, than from want of accurate discrimination of the varieties of condition both of the system at large and of the kidneys, when diuretics are indicated, and from the very common error of mingling in the same formula medicines of very opposite modes of action, though each singly may be a diuretic. [Diuretics.] The vapour of this, as well as of sulphuric ether, when copious, has proved fatal to those exposed to it. All bottles containing them should be well stopped or corked. Sweet spirit of nitre is a useful addition to copaiba, both as aiding to convert it into the form of mixture, and as a diuretic for diluting the acrimony of the urine, where copaiba is given in diseases of the bladder and urethra. (Christison.) Nitric ether is often fraudulently added to malt spirits to give them the flavour of French brandy. (Paris.)

Chloric ether is also markedly diuretic. It is a most valuable analeptic in the sinking stages of fevers, in asthma, and asthenic diseases of various kinds.

Acetic ether is a very agreeable stimulant, possessing a grateful odour, resembling Rhine wine, and a cooling, aromatic, somewhat bitterish taste. Its action is similar to that of the other ethers, and though not so potent, it is more agreeable to take. Its long-continued use however oppresses the digestive organs. Nevertheless it deserves to be employed in adynamic fevers, its action on the skin rendering it very advantageous. In tendency to fainting it is very serviceable; also in asphyxia. In some local affections it is of great utility applied in the form of vapour, such as some forms of deafness. (See Pilcher 'On the Ear.')

Phosphoric ether is a valuable restorative in the paralytic stage of fever.

For the employment of sulphuric ether as an anæsthetic agent, see Chloroform, and the work of Dr. J. C. Warren on 'Etherization.' Boston, U.S., 1848.

Collodion, which is a solution of gun-cotton in ether, is of considerable use in medicine. As a means of excluding the air from cuts, cracks, and sores, it is often better than ointments. It lessens the tendency to form pits and depressions of the skin in small pox, and is very effectual in stopping profuse bleeding from leech-bites.

ETHER, AMYLIC. Synonymous with *oxide of amyl.* [Amyl.]

ETHER, BUTYRIC. [Butyle.]

ETHER, CAMPHORIC. [Camphoric Acid.]

ETHEREAL SALTS. These organic bodies, called also *ethers* and *Compound Ethers*, are, like the true ethers, formed upon the model or type of water; they differ however from the ethers, inasmuch as one of the radicals replacing hydrogen is a negative radical. Thus, formic ether consists of water, in which one of the equivalents of hydrogen is replaced by the positive radical ethyl, and the remaining atom of hydrogen by the negative oxygenous radical formyl.

$$\text{Formic ether} \quad . \quad . \quad . \quad . \quad \left.\begin{matrix} C_4H_5 \\ C_2HO_3 \end{matrix}\right\} O_2$$

The constitution of these compounds is analogous to that of the salts of the oxygen acids amongst inorganic bodies.

The ethereal salts are produced by a variety of processes; for instance by the reaction of the alcohols upon the hydrated acids, the anhydrous acids, or the chlorides of the acid radicals. The hydrated organic acids generally require the intervention of sulphuric or hydrochloric acid to etherify them. The anhydrous acids are more easily etherified than the hydrated. Sometimes hydrated acid may be etherified by heating it with the simple ether in a sealed tube to about 650° Fahr. This is the case with the butyric, benzoic, and palmytic acids.

The ethereal salts are generally very mobile colourless liquids, possessing peculiar and often very agreeable odours, the fragrance of many fruits and flowers being due to the presence of small quantities of these bodies. They are neutral, volatile, and generally very sparingly soluble in water. Ammonia converts many of these ethereal salts into amides. [For the nature of the reaction see Amides.]

The above remarks refer exclusively to *monatomic* ethereal salts, that is, ethers constructed upon the model of the double molecule of water; there are, however, other classes of ethereal salts derived from bibasic and tribasic acids, and which are termed respectively *biatomic* and *triatomic* ethereal salts. The biatomic ethereal salts correspond to the quadruple molecule of water, thus:

$$\underbrace{\left.\begin{matrix} H \\ H \\ H \\ H \end{matrix}\right\} O_4}_{\text{Water.}} \qquad\qquad \underbrace{\left.\begin{matrix} C_4H_5 \\ C_4H_5 \\ C_2O_2 \\ C_2O_2 \end{matrix}\right\} O_4}_{\text{Oxalic ether.}}$$

Whilst the triatomic ethereal salts are constructed upon the model of the sextuple molecule of water, thus:

$$\underbrace{\left.\begin{matrix} H \\ H \\ H \\ H \\ H \\ H \end{matrix}\right\} O_6}_{\text{Water.}} \qquad\qquad \underbrace{\left.\begin{matrix} C_2H_3 \\ C_2H_3 \\ C_2H_3 \\ Cy \\ Cy \\ Cy \end{matrix}\right\} O_6}_{\text{Cyanate of methyl.}}$$

The biatomic and triatomic ethereal salts are produced by processes analogous to those employed for the preparation of the monatomic ethereal salts, with which they also possess great similarity of properties. A detailed description of these ethers is, when necessary, given under the name of the positive radical (Ethyl, for instance) which they contain.

ETHERENE. [Olefiant Gas.]

ETHERINE. Etherol. *Light oil of wine* ($C_{32}H_{33}$?). A peculiar oily hydrocarbon, formed during the preparation of ether. It boils at 526° Fahr.

ETHEROL. [Etherine.]

ETHERONE. Identical with Amylene.

ETHERS. This name has been applied in chemistry to three distinct classes of bodies, namely, 1st, to a series of compounds constituted like ether $\left(\text{vinic ether } \left.\begin{matrix} C_4H_5 \\ C_4H_5 \end{matrix}\right\} O_2\right)$; 2nd, to a class of bodies formed by the union of organic radicals like ethyl with the halogens, chlorine, iodine, &c., as

Iodide of ethyl . . . . . C_4H_5I
Chloride of methyl . . . . . C_2H_3Cl;

and 3rd, to a family of organic compounds, of which acetic ether $\left(\left.\begin{matrix} C_4H_5 \\ C_4H_3O_2 \end{matrix}\right\} O_2\right)$ may be taken as a type. To the first class of substances exclusively, we propose to apply the designation *Ethers*, the second may be conveniently termed *Haloid Ethers*, and the third *Ethereal Salts*.

Ethers. Several bodies belonging to this class have been long known; but although few organic compounds have been submitted to more elaborate investigation, yet it was not until the publication of the recent remarkable researches of Professor Williamson that the true nature and constitution of this important class of organic bodies became clearly established. According to this chemist, the ethers are constructed upon the type of the double atom of water, the same in fact upon which the alcohols are considered to be formed; but whilst in the alcohols only one of the equivalents of hydrogen in the double atom of water is replaced by a compound radical, in the ethers both equivalents of hydrogen are thus replaced.

These relations of alcohols and ethers to water will be best seen from the following examples:—

$$\text{Water} \quad . \quad . \quad . \quad . \quad . \quad . \quad \left.\begin{matrix} H \\ H \end{matrix}\right\} O_2$$

$$\text{Vinic alcohol} \quad . \quad . \quad . \quad . \quad . \quad \left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2$$

$$\text{Vinic ether} \quad . \quad . \quad . \quad . \quad . \quad \left.\begin{matrix} C_4H_5 \\ C_4H_5 \end{matrix}\right\} O_2$$

Sometimes the two equivalents of hydrogen in water are replaced by two different radicals, constituting what is termed a *mixed ether*, thus :—

$$\text{Methylovinic ether} \;\; . \;\; . \;\; . \;\; . \;\; \left.\begin{matrix}C_2H_3\\C_4H_5\end{matrix}\right\}O_2$$

The ethers are produced either by distilling the corresponding alcohols with concentrated sulphuric acid, which abstracts water from them,

$$\underbrace{2\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2}_{\text{Vinic alcohol.}} = \underbrace{\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2}_{\text{Vinic ether.}} + \left.\begin{matrix}H\\H\end{matrix}\right\}O_2$$

or by treating the potassiated alcohol with a haloid ether, thus :—

$$\underbrace{\left.\begin{matrix}C_4H_5\\K\end{matrix}\right\}O_2}_{\text{Ethylate of potash.}} + \underbrace{\left.\begin{matrix}C_4H_5\\I\end{matrix}\right\}}_{\text{Iodide of ethyl.}} = \underbrace{\left.\begin{matrix}K\\I\end{matrix}\right\}}_{\text{Iodide of potassium.}} + \underbrace{\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2}_{\text{Vinic ether.}}$$

The mixed ethers are most conveniently produced by the last re-action, thus :—

$$\left.\begin{matrix}C_4H_5\\K\end{matrix}\right\}O_2 + \underbrace{\left.\begin{matrix}C_2H_3\\I\end{matrix}\right\}}_{\text{Iodide of methyl.}} = \left.\begin{matrix}K\\I\end{matrix}\right\} + \underbrace{\left.\begin{matrix}C_2H_3\\C_4H_5\end{matrix}\right\}O_2}_{\text{Methylovinic ether.}}$$

The ethers are generally liquid at ordinary temperatures, but methylic ether is gaseous, and some of the higher terms of the family (as cetylic ether) are solid. They are neutral in their action upon test-papers, and are generally volatile without decomposition. In contact with strong acids they behave like the corresponding alcohols, although their affinities are of a less energetic character. A description of each ether will be found under the head of its constituent radical; thus, methylic ether under METHYL, and vinic ether under ETHYL.

Haloid Ethers. The haloid ethers constitute, in organic chemistry, a family of bodies occupying a position analogous to that of the hydracids, as hydrochloric acid, in inorganic compounds. In fact a hydracid is transformed into a haloid ether by replacing its hydrogen by an equivalent of a positive organic radical. Thus :—

$$\underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2}_{\text{Alcohol.}} + \underbrace{\left.\begin{matrix}H\\Cl\end{matrix}\right\}}_{\text{Hydrochloric acid.}} = \left.\begin{matrix}H\\H\end{matrix}\right\}O_2 + \underbrace{\left.\begin{matrix}C_4H_5\\Cl\end{matrix}\right\}}_{\text{Chloride of ethyl.}}$$

The haloid ethers closely resemble the ethers in their appearance; they are volatile odoriferous bodies, mostly liquid, although a few are gaseous, and others solid. In contact with alcoholic solution of potash they are decomposed, the alcohol from which the haloid ether was derived being regenerated.

$$\underbrace{\left.\begin{matrix}C_4H_5\\Cl\end{matrix}\right\}}_{\text{Chloride of ethyl.}} + \underbrace{\left.\begin{matrix}K\\H\end{matrix}\right\}O_2}_{\text{Hydrate of potash.}} = \underbrace{\left.\begin{matrix}K\\Cl\end{matrix}\right\}}_{\text{Chloride of potassium.}} + \underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2}_{\text{Alcohol.}}$$

The haloid ethers containing iodine are decomposed by zinc at elevated temperatures, with the separation of the radical. [ETHYL.] A description of the different haloid ethers will be found under the respective compound radicals.

ETHICS is the science which relates to our mental affections, not simply as a phenomena, but as they are virtuous or vicious, right or wrong. The term is derived from the Greek ἠθική, which is equivalent with the Latin *mos*, *mores*, whence the adjective *moralis*, and the English word *morals*. Aristotle, in the second book of his 'Ethics,' addressed to his son Nicomachus, says that moral science received the name of ethics from the word *éthos* (ἔθος), 'habit, use, or custom,' (ἠθικὴν, ἀπὸ τοῦ ἔθους, or ἀπὸ τῶν ἠθῶν), since it is from habitual experience, and routine of customary conduct that moral dispositions and principles are gradually formed and changed. Cicero, in his work on Moral Ends ('De Finibus,' 1 and 5), briefly defines ethics, or morality, as the 'ars vivendi,' or 'doctrina bene vivendi,' that is, the art of living wisely. The scholastic treatises on ethics divide the practical part of the science into three departments, *éthike* (ἠθική), which shows by appropriate precepts what is the duty of a good man; *œconómike* (οἰκονομική), which shows what is the duty of a good father of a family; and *politike* (πολιτική), which exhibits the duty of a good citizen, and of a good magistrate. [MORALS.]

ETHIONIC ACID (C_4H_4, 2HO, $4SO_3$). This acid is prepared by passing the vapour of anhydrous sulphuric acid slowly into absolute alcohol kept cold; by their mutual action an oleaginous fluid is formed, without the evolution of any gaseous matter. This fluid is to be mixed with water and saturated with baryta, by which a portion of sulphate is separated, and ethionate of baryta is obtained by evaporation in vacuo.

Ethionic acid may also be prepared by the action of anhydrous sulphuric acid upon olefiant gas.

ETHIOPS' MINERAL. [MERCURY, *sulphide of*.]

ETHYL $\left(\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}\right)$. This Organic Radical is one of the most important of the class of chemical compounds to which it belongs. It is not only capable of being obtained in a separate or free state, but it also forms a more numerous and better studied class of organic compounds than any other organic radical. In all its compounds it stands in the same relation to the element or elements with which it is united, as hydrogen occupies when analogously united with the same elements. Thus we have

$$\underbrace{\left.\begin{matrix}H\\H\end{matrix}\right\}O_2}_{\text{Oxide of hydrogen, or water.}} \quad \text{and} \quad \underbrace{\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}O_2}_{\text{Oxide of ethyl, or ether.}}$$

$$\underbrace{\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}}_{\text{Acetic acid.}} \quad \text{and} \quad \underbrace{\left.\begin{matrix}C_4H_3O_2\\C_4H_5\end{matrix}\right\}O_2}_{\text{Acetic ether.}}$$

$$\underbrace{\left.\begin{matrix}H\\I\end{matrix}\right\}}_{\text{Hydriodic acid.}} \quad \text{and} \quad \underbrace{\left.\begin{matrix}C_4H_5\\I\end{matrix}\right\}}_{\text{Iodide of ethyl.}}$$

$$\underbrace{N\left\{\begin{matrix}H\\H\\H\end{matrix}\right.}_{\text{Ammonia.}} \quad \text{and} \quad \underbrace{N\left\{\begin{matrix}C_4H_5\\C_4H_5\\C_4H_5\end{matrix}\right.}_{\text{Triethylamine.}}$$

These examples, which might be greatly multiplied, show that ethyl possesses the closest chemical relationship to hydrogen, and as hydrogen in its elementary or free condition is now usually represented by chemists as a double atom $\left(\left.\begin{matrix}H\\H\end{matrix}\right\}\right)$, so the formula of ethyl is now usually written double $\left(\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}\right)$

Ethyl may be readily prepared in a state of purity by decomposing iodide of ethyl by granulated zinc, in a sealed glass tube, at a temperature of about 300° Fahr. The following decomposition takes place :—

$$\underbrace{2\left.\begin{matrix}C_4H_5\\I\end{matrix}\right\}}_{\text{Iodide of ethyl.}} + Zn_2 = \underbrace{2\left\{\begin{matrix}Zn\\I\end{matrix}\right.}_{\text{Iodide of zinc.}} + \underbrace{\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}}_{\text{Ethyl.}}$$

Simultaneously with this reaction there occurs another, by which *zincethyl* is produced (see *zincethyl*, col. 982). A portion of the ethyl is also decomposed into hydride of ethyl and olefiant gas.

$$\underbrace{\left.\begin{matrix}C_4H_5\\C_4H_5\end{matrix}\right\}}_{\text{Ethyl.}} = \underbrace{C_4H_4}_{\text{Olefiant gas.}} + \underbrace{\left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}}_{\text{Hydride of ethyl.}}$$

On breaking off the extremity of the sealed glass tube beneath the edge of an inverted receiver filled with water and standing on the shelf of the pneumatic trough, the gaseous products of the decomposition, namely, ethyl, olefiant gas, and hydride of ethyl, rush out with great violence; but, owing to a portion of the ethyl being liquified in the tube by the great pressure, that body requires more time for its complete gasification than is necessary for the complete expulsion of the hydride of ethyl and olefiant gas: consequently, if the last portion of gas be collected apart, it is found to consist of pure ethyl.

Ethyl is a colourless gas, possessing a very slight ethereal odour, burning with a brilliant white flame, and having a specific gravity of 2·0039. It is incondensable at a temperature of 0° Fahr., but exposed to a pressure of 2¼ atmospheres at 37° Fahr. it condenses to a colourless, transparent, and mobile liquid, which instantly resumes the gaseous condition on the pressure being removed. Its boiling point is consequently about —9·5° Fahr. Alcohol absorbs about 18 times its volume of this gas. It is also slightly soluble in water, and considerably so in ether.

Ethyl, once isolated, cannot be made to re-combine with any element at ordinary temperatures. In this respect it also resembles hydrogen, but in the case of this element the application of a red heat serves to make it combine with most negative elements, as oxygen, sulphur, chlorine, &c.: but a less degree of heat applied to ethyl utterly decomposes this radical, and hence all attempts to re-combine ethyl have hitherto failed.

Although no compound of ethyl can be directly formed from the radical, yet a large number of such compounds may be obtained from its hydrated oxide $\left(\text{alcohol } \left.\begin{matrix}C_4H_5\\H\end{matrix}\right\}O_2\right)$, and we will now describe some of the most important of these compounds.

Hydride of ethyl (C_4H_5,H). Obtained by heating together equal parts of water and of iodide of ethyl with granulated zinc, for a couple of hours, in a hermetically sealed tube or digester [DIGESTER], at a temperature of about 380° Fahr. The following equation represents the decomposition that takes place:—

$$\underbrace{C_4H_5,I}_{\text{Iodide of ethyl.}} + \underbrace{Zn_2}_{\text{Zinc.}} + \underbrace{HO}_{\text{Water.}} = \underbrace{ZnI}_{\text{Iodide of zinc.}} + \underbrace{ZnO}_{\text{Oxide of zinc.}} + \underbrace{C_4H_5,H}_{\text{Hydride of ethyl.}}$$

It may also be obtained by decomposing moist cyanide of ethyl with potassium, as noticed under CYANETHINE.

Hydride of ethyl is a permanent gas, insoluble in water, and may therefore be collected by opening the vessel in which it has been made under a bell jar in the pneumatic trough. It is colourless, odourless, and tasteless. Sp. gr. 1·075. Alcohol absorbs rather more than its own volume of this gas. Chlorine acts upon it, replacing the hydrogen in it, to a greater or less extent according as the mixture of the gases is exposed to the direct rays of the sun or merely to diffused daylight.

Oxide of ethyl; Ether; Æther; Ethylic ether; Vinic ether; Sulphuric ether $\left(\left\{\begin{matrix} C_4H_5O \\ C_4H_5O \end{matrix}\right\}\right)$.

This compound was first called ether in 1730 by Frobenius. [FROBEN, in BIOG. DIV.] It was known, however, long prior to that date. Conrad Gesner, in a work published in 1552, transcribed the process of making it from the dispensatory of Valerius Cordus, and gives to it the name *Oleum Vitrioli dulce*. It is also said to have been known to Raymond Lully, who lived in the 13th century. During the last fifty years it has been made the subject of research by several eminent chemists, and the theory put forward by Berzelius that it was the oxide of a (then) hypothetical radical ethyl, has since been established by Liebig, Williamson, and others.

The best method of preparing ether is that known as Boullay's Continuous Process. It consists of an arrangement by which a small stream of alcohol (sp. gr. 0·830) supplied from a reservoir is made to flow into a vessel containing equal volumes of alcohol and sulphuric acid, the latter mixture being maintained at a temperature between 284° and 290° Fahr. The alcohol is then rapidly decomposed into ether and water, which distil off in vapour, and must be condensed in a well-cooled refrigerating apparatus. This process may be continued without interruption by means of some such arrangement of apparatus as that figured under CONDENSER (the alcohol supply-tube passing through the cork of the flask there represented), until full thirty times the weight of the quantity of alcohol first mixed with the sulphuric acid has been etherified.

The ether thus obtained may be purified by agitating with an equal bulk of water containing $\frac{1}{10}$th its weight of carbonate of potash in solution. The water dissolves out any alcohol that may have distilled over unchanged, and the carbonate of potash neutralises sulphurous acid which is occasionally formed in small quantity from decomposition of a little of the sulphuric acid. The ether, however, still contains in solution some of the water with which it has been agitated: this may, if necessary, be removed by digesting some pieces of chloride of calcium, or quicklime, in it for a day or two, and then rectifying by the heat of a water-bath, and condensing by an ice-cooled refrigeratory. For some economical methods of condensing and purifying ether on the large scale, see article 'Ether' in Muspratt's 'Chemistry as applied to Arts and Manufactures.'

The decomposition that occurs during the process above described is usually explained in the following manner: Sulphethylic or sulphovinic acid and water, are first formed from one equivalent of alcohol and two equivalents of sulphuric acid, thus:—

$$\underbrace{\left.\begin{matrix} H \\ H \end{matrix}\right\} O_2, S_2O_6}_{\text{Double equiv. of sulphuric acid.}} + \underbrace{\left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2}_{\text{Alcohol.}} = \underbrace{\left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2, S_2O_6}_{\text{Sulphovinic acid.}} + \underbrace{\left.\begin{matrix} H \\ H \end{matrix}\right\} O_2}_{\text{Water.}}$$

The sulphovinic acid is then decomposed on coming into contact with another equivalent of alcohol, its ethyl being replaced by the equivalent of hydrogen turned out from the second equivalent of alcohol, and sulphuric acid and ether formed:—

$$\underbrace{\left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2, S_2O_6}_{\text{Sulphovinic acid.}} + \underbrace{\left.\begin{matrix} C_4H_5 \\ H \end{matrix}\right\} O_2}_{\text{Alcohol.}} = \underbrace{\left.\begin{matrix} C_4H_5 \\ C_4H_5 \end{matrix}\right\} O_2}_{\text{Ether.}} + \underbrace{\left.\begin{matrix} H \\ H \end{matrix}\right\} O_2, S_2O_6}_{\text{Sulphuric acid.}}$$

The sulphuric acid thus set at liberty is free to commence the same round of re-actions over again.

Other substances besides sulphuric acid are capable of etherifying alcohol, but they are of no practical importance.

Pure ether is a colourless, limpid, mobile liquid. It is a powerful refractor of light, has a peculiarly penetrating odour, and a taste at first hot but afterwards cooling. It is neutral to test-paper; has a sp. gr. of 0·724 at 55° Fahr.; boiling point, 94·8° Fahr.; and on being cooled to —24° Fahr. crystallises in brilliant white plates. Ether is exceedingly inflammable; and as its vapour is heavy (2·565), great caution is necessary that the operation of pouring it from one vessel to another be not performed in the vicinity of a naked flame. Moreover, the vapour forms, with certain proportions of atmospheric air, a mixture that burns with explosive rapidity. Ether is miscible with alcohol in all portions. When agitated with water, each liquid dissolves its companion to the extent of one-eighth of its own bulk.

Ether is acted upon by most of the energetic chemical reagents, as will be abundantly seen on looking over the processes for the production of many of the ethyl compounds that follow. It is of considerable value as a medicinal agent producing stimulating and intoxicating effects when taken into the stomach. It was much used as an anæsthetic a few years ago, but for that purpose is now quite superseded by chloroform. [ANÆSTHETICS.]

Ether, like potash, soda, &c., unites with the oxyacids, forming many interesting and useful compounds. The method of preparing the principal of these will be found described under the respective acids. Many of them may be formed by acting upon the potash or soda-salt of the acid, with a mixture of alcohol and sulphuric acid, that is, with sulphovinic acid. The formulæ of some of these ETHEREAL SALTS, and their general relation to other ethyl compounds, will be shown at the latter part of this article.

Acetic ether has an agreeable odour somewhat like that of apples. It occurs in several wines. *Angelic ether* smells like rotten apples. *Butyric ether* is used as essence of pine-apples; *caproic* and *caprylic ethers* having a similar odour. *Formic ether* in taste and smell is like peach kernels. *Nitrous ether*, dissolved in alcohol, is the *sweet spirit of nitre* of pharmacy; the *spiritus etheris nitrosi* of the London pharmacopœia. *Œnanthic ether* causes the peculiar vinous odour of most wines.

Hydrated oxide of ethyl ($C_4H_6O_2 = C_4H_5O, HO$), or *Alcohol*, has already been fully treated of. [ALCOHOL.]

Chlorine derivatives of oxide of ethyl. Chlorine acts upon ether, giving rise to substitution compounds in which the hydrogen is more or less replaced. The following formulæ will conveniently show their relation to ether:—

Oxide of chlorethyl . . . . $C_4\left\{\begin{matrix} H_4 \\ Cl \end{matrix}\right\}O$

Oxide of bichlorethyl . . . . $C_4\left\{\begin{matrix} H_3 \\ Cl_2 \end{matrix}\right\}O$

Oxide of perchlorethyl . . . . C_4Cl_5, O

Oxide of perchlorbromethyl . . . $C_4\left\{\begin{matrix} Cl_3 \\ Br_2 \end{matrix}\right\}O$

Sulphides of ethyl. There are three of these, namely:—

1. Mercaptan (sulphydrate of ethyl, or ethylsulphydric acid) . . . . . . $\left\{\begin{matrix} C_4H_5S \\ H\ S \end{matrix}\right\}$
2. Sulphide of ethyl . . . . . . $\left.\begin{matrix} C_4H_5S \\ C_4H_5S \end{matrix}\right\}$
3. Bisulphide of ethyl . . . . . $\left.\begin{matrix} C_4H_5S_2 \\ C_4H_5S_2 \end{matrix}\right\}$

1. Mercaptan may be produced in several ways. The following is the most expeditious. Sulphovinate of potash is added to excess of caustic potash that has previously been saturated with sulphuretted hydrogen, and the whole submitted to distillation. An exceedingly well cooled condenser must be used in the operation.

$$\underbrace{KO, C_4H_5O, S_2O_6}_{\text{Sulphovinate of potash.}} + \underbrace{KS, HS}_{\text{Sulphydrate of potassium.}} = \underbrace{C_4H_5S, HS}_{\text{Mercaptan.}} + \underbrace{2(KO, SO_3)}_{\text{Sulphate of potash.}}$$

Mercaptan is a colourless, transparent, mobile liquid of an excessively disgusting smell. Its sp. gr. at 70° Fahr. is 0·835. Vapour-density 2·11. Boiling point 142°–145°. Burns readily in air with a blue flame; is slightly soluble in water, readily so in alcohol or ether. Its volatility is such that when a glass rod moistened with it is passed quickly through the air, a temperature (–8° Fahr.) is produced sufficiently low to solidify what may be remaining on the rod.

Mercaptan forms compounds with the metals called *mercaptides* or *ethylsulphides*. They are monobasic. The potash and soda salts may be obtained by simply dropping potassium or sodium into mercaptan, an equivalent of metal replacing one equivalent of hydrogen from one of mercaptan. An alcoholic solution of mercaptan acts with great energy upon oxide of mercury (hence the name mercaptan, from *mercurium captans*), and forms white, crystalline, odourless, *mercaptide of mercury* (HgS, C_4H_5S). The gold, silver, and copper salts are white; those of platinum and lead are yellow. Mercaptan may be regarded as alcohol in which the oxygen is replaced by sulphur.

2. Sulphide of ethyl, or sulphydric ether, is readily prepared on passing a current of chloride of ethyl into an alcoholic solution of protosulphide of potassium to saturation, and then distilling the mixture. It is a colourless liquid, odour almost as unpleasant as mercaptan; sp. gr. 0·825, vapour-density 3·1, boiling point 163·4°. It forms combinations with some of the metallic chlorides.

3. Bisulphide of ethyl. Obtained on distilling three parts of sulphovinate of potash with two of pentasulphide of potassium. It is colourless, has a disagreeable odour, is slightly soluble in water, and very soluble in alcohol or ether. Its sp. gr. is nearly that of water, boiling point 304°, vapour-density 4·27.

Selenides of ethyl are two in number:

1. Ethylselenhydric acid . . . . $\left.\begin{matrix} C_4H_5Se \\ H\ Se \end{matrix}\right\}$
2. Selenide of ethyl . . . . . $\left.\begin{matrix} C_4H_5Se \\ C_4H_5Se \end{matrix}\right\}$

1. Ethylselenhydric acid is a yellow fetid liquid, resulting from the distillation of a mixture of sulphovinate of lime and selenhydrate of potash. It is heavier than water; boiling point about 212° Fahr.

2. Selenide of ethyl, or selenhydric ether, is a clear yellow liquid heavier than water. It is formed on distilling selenide of potassium with sulphethylate of potash. It combines with chlorine, bromine, iodine, &c., forming compounds of much theoretical but little general interest.

Telluride of ethyl $\left.\begin{matrix}C_4H_5Te\\C_4H_5Te\end{matrix}\right\}$ comports itself like selenide of ethyl. It may be obtained by distilling telluride of potassium with sulphovinate of potash. It has a yellowish-red colour, persistent disagreeable odour, boiling point about 212° Fahr., and is rapidly altered in contact with air.

Fluoride of ethyl (C_4H_5, F) is a mobile very volatile liquid, having an odour somewhat resembling that of horseradish.

Chloride of ethyl (C_4H_5Cl.), *hydrochloric ether*, may be readily prepared by distilling a mixture of three parts of strong sulphuric acid, two of alcohol, and four of fused chloride of sodium. Two condensers must be used in the operation, the first kept at a temperature of about 70° Fahr., from which water and alcohol will be collected; the second, cooled with ice, or a freezing mixture, in which the chloride of ethyl will collect. It may be rectified over chloride of calcium.

Chloride of ethyl has a powerfully aromatic, faintly alliaceous odour. Its sp. gr. at 41° Fahr., is 0·874. Vapour-density, 2·219. Boiling point, 52° Fahr. It burns with a bright flame edged with green, is very slightly soluble in water, but freely so in alcohol. It is a solvent of sulphur, phosphorus, fats, oils, and resins. Its vapour passed through a red hot porcelain tube is decomposed into olefiant gas (C_4H_4) and hydrochloric acid.

Chlorine derivatives of chloride of ethyl. Chlorine acts upon chloride of ethyl, heat is evolved, and hydrochloric acid produced by the union of part of the chlorine with hydrogen that is displaced by another part of the chlorine. In this way an interesting series of substitution-compounds is obtained, in which the five equivalents of hydrogen in chloride of ethyl are successively replaced by equivalents of chlorine. The following list of these compounds, with their formulæ, will at once show the relation they bear to chloride of ethyl and to each other:—

Chloride of ethyl	$C_4\ H_5\ Cl$
" chlorethyl	$C_4\left\{\begin{matrix}H_4\\Cl\end{matrix}\right\}Cl$
" bichlorethyl . . .	$C_4\left\{\begin{matrix}H_3\\Cl_2\end{matrix}\right\}Cl$
" trichlorethyl	$C_4\left\{\begin{matrix}H_2\\Cl_3\end{matrix}\right\}Cl$
" quadrichlorethyl . . .	$C_4\left\{\begin{matrix}H\\Cl_4\end{matrix}\right\}Cl$
" perchlorethyl	$C_4\ Cl_5\ Cl$

The last is identical with the sesquichloride of carbon (C_4Cl_6). [CHLORINE; CARBON.]

Bromide of ethyl, or *hydrobromic ether* (C_4H_5Br), is made much in the same way as the next compound—iodide of ethyl—bromine being used instead of iodine. It is a colourless liquid of penetrating ethereal odour and taste. Its sp. gr. is 1·4733 at 32° Fahr. Vapour-density, 3·754. Boiling point, 106°. It is almost insoluble in water, but miscible in all proportions with alcohol or ether.

Iodide of ethyl (C_4H_5I), *hydriodic ether.* To 100 parts of alcohol contained in a capacious flask there are alternately added, by small portions at a time, 60 parts of iodine and 20 parts of phosphorus. If the action becomes violent during the operation, a cork should be put into the neck of the flask, and the whole plunged beneath the surface of cold water. The mixture is finally distilled, care being taken that a slight excess of iodine is present, which will be the case if the mixture keeps of a brown colour. The condensed iodide of ethyl should be allowed to flow into a receiver containing water, at the bottom of which it will collect. After separating the water, the iodide of ethyl may be obtained in a perfectly pure state, on rectifying from a few pieces of chloride of calcium. In the above process the iodine and phosphorus first combine to form iodide of phosphorus; this, with the elements of water, is then decomposed into phosphorous acid and hydriodic acid, and the latter reacting upon alchohol produces iodide of ethyl and water.

Iodide of ethyl is a neutral liquid, colourless when pure, but becoming brown by the action of air and light, from liberation of iodine. Its odour is ethereal and penetrating. It is exceedingly heavy, having at 61° Fahr., a sp. gr. of 1·9464. Its boiling point is 162°·2 Fahr. Vapour-density 5·475. It is scarcely at all soluble in water, but very soluble in alcohol. It burns with difficulty. Heated with water in a sealed tube to 302° Fahr., it is decomposed into ether and hydriodic acid; if oxide of silver be present, then alcohol and iodide of silver are formed.

Nitrides of ethyl. [ORGANIC BASES.]

Cyanide of ethyl ($C_6H_5N = C_4H_5Cy$), ***hydrocyanic ether, metacetonitrile, propionitrile.*** Equal weights of sulphovinate of potash and of cyanide of potassium are powdered, intimately mixed, and heated together in a retort; the distillate, which has a disagreeable alliaceous odour should be washed with water, and rectified over anhydrous phosphoric acid. Thus obtained, it is a colourless liquid of agreeable odour, sp. gr. 0·78. Boiling point 179°·6 Fahr. It is said to be excessively poisonous, but of this there is some doubt, as, prepared by the above process, it always contains hydrocyanic acid, &c. A boiling solution of potash converts it into propionate of potash with disengagement of ammonia.

$$\underbrace{C_4H_5,\ C_2N}_{\text{Cyanide of ethyl.}} + KO,\ HO + 2HO = \underbrace{KO,\ C_6H_5O_3}_{\text{Propionate of potash.}} + NH_3$$

For the action of potassium on cyanide of ethyl, see CYANETHINE.

Ethide of sodium (C_4H_5, Na), *sodium ethyl.* Mr. Wanklyn has recently discovered a combination of this compound with two equivalents of zinc-ethyl ($NaC_4H_5 + 2\,ZnC_4H_5$). It is formed by acting upon zinc-ethyl with sodium, when metallic zinc is precipitated, and sodium dissolved, equivalent for equivalent. The double compound may be obtained in crystals from solution in zinc-ethyl. Heat decomposes the crystals, gas is evolved, and the residue consists of sodium and zinc, without any admixture of carbon. The action of carbonic acid on the crystals is interesting, heat is evolved, zinc-ethyl distils off, and there remains a white residue of propionate of soda. The re-action is expressed in the following equation:—

$$C_2O_4 + Na,\ C_4H_5 = \left.\begin{matrix}C_2O_2C_4H_5\\Na\end{matrix}\right\}O_2$$

Ethide of potassium (C_4H_5Na), *potassium ethyl*, is obtained in the same manner, and, so far as at present ascertained, closely resembles the ethide of sodium just described.

Ethide of zinc (C_4H_5Zn), *zinc-ethyl.* Obtained by heating together in a sealed glass tube, or digester, equal volumes of iodide of ethyl and ether, both perfectly anhydrous, and a quantity of well-dried granulated zinc, equal to about twice the weight of the iodide of ethyl. A heat of about 250° Fahr. should be kept up for fifteen or twenty hours. When cool the vessel may be opened, and the zinc-ethyl distilled off from the residue of iodide of zinc, contact with air being avoided as much as possible.

Zinc-ethyl is a colourless, transparent, mobile liquid. Boiling point 244° Fahr. Sp. gr. at 64° Fahr. 1·182. Vapour-density, 4·259. Its affinity for oxygen is so intense as to render it spontaneously inflammable in the air, when it burns with a brilliant blue flame, fringed with green, and forms dense white clouds of oxide of zinc. Allowed to oxidise slowly, a white substance results containing C_4H_5O, Zn O, the *ethylate of zinc* or *zinc alcohol.* [ORGANOMETALLIC BODIES.]

Ethide of tin (C_4H_5Sn), *stanethyl.* Formed by the re-action of granulated tin and iodide of ethyl with the aid of heat or light. By double decomposition of the iodide of stanethyl thus produced, an oxide, chloride, sulphide, &c., may be formed, and the stanethyl itself isolated by the action of metallic zinc on the chloride of stanethyl.

Stanethyl is a yellow oily liquid, decomposed by a heat of about 300° Fahr.

Other compounds of ethyl and tin also exist. [ORGANOMETALLIC BODIES.]

Terethide of antimony ($3C_4H_5$, Sb), *stibethyl.* Obtained by acting upon iodide of ethyl with an alloy of antimony and potassium. It is a heavy limpid liquid, has a powerful odour of onions, and is spontaneously inflammable. Sp. gr. 1·324, vapour-density 7·438, boiling point 317°. It forms salts with oxygen, iodine, sulphur, &c.

Binethide of arsenic ($2C_4H_5$, As), *arseniodiethyl*, and its compounds are very similar to cacodyl, the bimethide of arsenic. [CACODYL.]

Terethide of arsenic ($3C_4H_5$, As), *arseniotriethyl*, is the chief product of the action of iodide of ethyl on an alloy of arsenic and sodium. It is scarcely spontaneously inflammable. Its compounds have a very close analogy to those of terethide of antimony.

Terethide of bismuth ($3C_4H_5$, Bi), *bistriethyl*, results from the action of iodide of ethyl upon an alloy of bismuth and potassium. It is a yellowish liquid of disagreeable odour. Sp. gr. 1·82. It combines with the metalloids.

Ethide of mercury, mercuryethyl, hydrargethyl, has been obtained in combination, and several of the salts described.

Ethide of lead, plumbethyl, forms in combination salts that correspond to binoxide of lead (Pb_2O_4). The oxide of plumbethyl contains $Pb_2\ (C_4H_5)_3O$ and the chloride $Pb_2\ (C_4H_5)_3Cl$.

Ethide of cadmium (C_4H_5, Cd), *cadmium-ethyl*, may be formed by a process similar to that for making zinc-ethyl. It has not yet been procured in a state of perfect purity.

The following are the names and formulæ of the remaining more important compounds of ethyl. The preparation and properties of the most interesting of them will be found described in the article treating of the several bodies with which the ethyl is combined.

Ethyl-acetamide	$N\left\{\begin{matrix}C_4H_3O_2\\C_4H_5\\H\end{matrix}\right.$
Ethyl-diacetamide	$N\left\{\begin{matrix}C_4H_3O_2\\C_4H_3O_2\\C_4H_5\end{matrix}\right.$

Ethylamine	$N\left\{\begin{matrix}C_4H_5\\H\\H\end{matrix}\right.$
Diethylamine	$N\left\{\begin{matrix}C_4H_5\\C_4H_5\\H\end{matrix}\right.$
Triethylamine	$N\left\{\begin{matrix}C_4H_5\\C_4H_5\\C_4H_5\end{matrix}\right.$
Tetrethylammonium hyd. ox.	$N\left\{\begin{matrix}C_4H_5\\C_4H_5\\C_4H_5\\C_4H_5\end{matrix}\right\}O, HO$
Ethyl-amyl	$\left\{\begin{matrix}C_4H_5\\C_{10}H_{11}\end{matrix}\right.$
Ethylaniline	$N\left\{\begin{matrix}C_{12}H_5\\C_4H_5\\H\end{matrix}\right.$
Diethylaniline	$N\left\{\begin{matrix}C_{12}H_5\\C_4H_5\\C_4H_5\end{matrix}\right.$
Ethylchloraniline	$N\left\{\begin{matrix}C_{12}H_4Cl\\C_4H_5\\H\end{matrix}\right.$
Diethylchloraniline	$N\left\{\begin{matrix}C_{12}H_4Cl\\C_4H_5\\C_4H_5\end{matrix}\right.$
Ethylbromaniline	$N\left\{\begin{matrix}C_{12}H_4Br\\C_4H_5\\H\end{matrix}\right.$
Ethylnitraniline	$N\left\{\begin{matrix}C_{12}H_4NO_4\\C_4H_5\\H\end{matrix}\right.$
Ethylcyaniline	$N\left\{\begin{matrix}C_{12}H_4Cy\\C_4H_5\\H\end{matrix}\right.$
Ethylamylaniline	$N\left\{\begin{matrix}C_{12}H_5\\C_4H_5\\C_{10}H_{11}\end{matrix}\right.$
Ethylcarbamate of ethyl	$\left.\begin{matrix}NH(C_4H_5)(CO)_2O\\C_4H_5, O\end{matrix}\right\}$
Ethylcodeine	$C_{36}\left\{\begin{matrix}H_{20}\\C_4H_5\end{matrix}\right\}NO_6$
Ethylconine	$N(C_{16}H_{14})(C_4H_5)$
Ethylformiamide	$N\left\{\begin{matrix}C_2HO_2\\C_4H_5\\H\end{matrix}\right.$
Ethylmorphine	$C_{34}\left\{\begin{matrix}H_{18}\\C_4H_5\end{matrix}\right\}NO_6$
Ethylnarcotine	$C_{42}\left\{\begin{matrix}H_{20}\\C_4H_5\end{matrix}\right\}NO_{14}$
Ethylnicotine	$NC_{10}H_7(C_4H_5)$
Ethylnitrophenidine	$C_{16}H_{10}(NO_4)NO_2$
Ethylpicoline	$C_{12}H_7(C_4H_5)N$
Ethylpiperidine	$NC_{10}H_{10}(C_4H_5)$
Ethylpyridine	$NC_{10}H_5(C_4H_5)$
Ethylquinine	$C_{40}H_{24}(C_4H_5)N_2O_4$
Ethylstrychnine	$C_{42}H_{21}(C_4H_5)N_2O_4$
Ethylthiosinnamine	$\left.\begin{matrix}NH_2(C_4H_5)(C_6H_5)S\\Cy\ S\end{matrix}\right\}$
Ethyltoluidine	$N\left\{\begin{matrix}C_{14}H_7\\C_4H_5\\H\end{matrix}\right.$
Diethyltoluidine.	$N\left\{\begin{matrix}C_{14}H_7\\C_4H_5\\C_4H_5\end{matrix}\right.$
Ethyl-urea	$N_2\left\{\begin{matrix}C_2O_2\\C_4H_5\\H_3\end{matrix}\right.$
Ethylmethylurea	$N_2\left\{\begin{matrix}C_2O_2\\C_4H_5\\C_2H_3\\H_2\end{matrix}\right.$
Tetrethylurea	$N_2\left\{\begin{matrix}C_2O_2\\2(C_4H_5)\\2(C_4H_5)\end{matrix}\right.$

Ethyl-urethane (carbamate of ethyl). [CARBAMIC ACID.]

Acids containing Ethyl.

Ethylamylcitric acid	$C_{12}H_6(C_4H_5)(C_{10}H_{11})O_{14}$
Ethylcamphoric acid	$C_{20}H_{15}(C_4H_5)O_8$
Ethylcarbamic acid	$\left.\begin{matrix}NH(C_4H_5)(CO)_2O\\HO\end{matrix}\right\}$
Ethylcarbonic acid	$C_2O_4\left\{\begin{matrix}C_4H_5O\\HO\end{matrix}\right.$
Ethylchloroplatinic acid	$C_4H_4Pt, PtCl_2$
Ethylcomenic acid	$C_{12}H_3(C_4H_5)O_{10}$
Ethylhemipinic acid	$C_{20}H_9(C_4H_5)O_{12}$
Ethylmalic acid	$C_8H_5(C_4H_5)O_{10}$
Ethylmeconic acid	$C_{14}H_3(C_4H_5)O_{14}$
Diethylmeconic acid	$C_{14}H_2(C_4H_5)_2O_{14}$
Ethylmellic acid	$C_8H(C_4H_5)O_8$
Ethylmucic acid	$C_{12}H_9(C_4H_5)O_{16}$
Ethylotrithionic acid	$S_3(C_4H_5)O_6$
Ethyloxalic acid	$C_4O_6\left\{\begin{matrix}C_4H_5O\\H\ O\end{matrix}\right.$
Ethyloxamic acid	$\left.\begin{matrix}NH(C_4H_5)(C_2O_2)_2O\\H\ O\end{matrix}\right\}$
Ethylparatartric acid	$C_8H_5(C_4H_5)O_{12}$
Ethylphosphorous acid	$C_4H_5O, 2HO, PO_3$
Ethylphosphoric acid	$\left.\begin{matrix}C_4H_5O\\H\ O\\H\ O\end{matrix}\right\}PO_5$
Diethylphosphoric acid	$\left.\begin{matrix}C_4H_5O\\C_4H_5O\\H\ O\end{matrix}\right\}PO_5$
Ethylsulphophosphoric acid	$\left.\begin{matrix}C_4H_5O\\HS\\HS\end{matrix}\right\}PO_5$
Ethylsulphocarbonic acid	$C_2O_4\left\{\begin{matrix}C_4H_5S\\H\ S\end{matrix}\right.$
Ethyldisulphocarbonic acid	$C_2S_4\left\{\begin{matrix}C_4H_5O\\H\ O\end{matrix}\right.$
Ethyltrisulphocarbovinic acid	$C_2S_4\left\{\begin{matrix}C_4H_5S\\H\ S\end{matrix}\right.$
Ethylsulphurous acid	$\left.\begin{matrix}C_4H_5O\\H\ O\end{matrix}\right\}S_2O_4$
Ethylsulphuric acid	$\left.\begin{matrix}C_4H_5O\\H\ O\end{matrix}\right\}S_2O_6$
Ethyltartric acid	$C_8H_5(C_4H_5)O_{12}$

Ethereal Salts—Compounds containing oxide of ethyl united with an acid. [ETHERS.]

Acetic ether	$C_4H_5O, C_4H_3O_3$
Aconitic ether	$3C_4H_5O, C_{12}H_3O_9$
Allophanic ether	$C_4H_5O, C_4H_3N_2O_5$
Angelic ether	$C_4H_5O, C_{10}H_7O_3$
Anisic ether	$C_4H_5O, C_{16}H_7O_5$
Benzoic ether	$C_4H_5O, C_{14}H_5O_3$
Boracic ether	$3C_4H_5O, BO_3$
Butylic ether	C_4H_5O, C_8H_9O
Butyric ether	$C_4H_5O, C_8H_7O_3$
Camphoric ether	$2C_4H_5O, C_{20}H_{14}O_6$
Capric ether (rutic ether)	
Caproic ether	$C_4H_5O, C_{12}H_{11}O_3$
Caprylic ether	$C_4H_5O, C_{16}H_{15}O_3$
Carbamic ether	$C_4H_5O, C_2H_2NO_3$
Carbanilic ether	$C_4H_5O, C_{14}H_6NO_3$
Carbonic ether	$2C_4H_5O, C_2O_4$
Cerotic ether	$C_4H_5O, C_{54}H_{53}O_3$
Chloracetic ether	$C_4H_5O, C_4Cl_3O_3$
Chlorocarbonic ether	C_4H_5Cl, C_2O_4
Cinnamic ether	$C_4H_5O, C_{18}H_7O_3$
Citraconic ether	$C_4H_5O, C_{14}H_9O_7$
Citric ether	$3C_4H_5O, C_{12}H_5O_{11}$
Cyanic ether	C_4H_5O, C_2NO
Cyanuric ether	$3C_4H_5O, C_6N_3O_3$
Elaidic ether	$C_4H_5O, C_{36}H_{33}O_3$
Formic ether	C_4H_5O, C_2HO_3
Fumaric ether	$C_4H_5O, C_8H_2O_7$
Hypogeic ether	$C_4H_5O, C_{32}H_{29}O_3$
Isocetic ether	$C_4H_5O, C_{30}H_{29}O_3$
Itaconic ether	$C_4H_5O, C_{10}H_4O_7$
Lactic ether	$2C_4H_5O, C_{12}H_{10}O_{10}$
Lecanoric ether (orsellesic ether)	
Margaric ether	$C_4H_5O, C_{34}H_{33}O_3$
Mesaconic ether	$C_4H_5O, C_{14}H_9O_7$
Mucic ether	$2C_4H_5O, C_{12}H_8O_{14}$
Myristic ether	$C_4H_5O, C_{28}H_{27}O_3$
Nitric ether	C_4H_5O, NO_5
Nitrous ether	C_4H_5O, NO_3
Œnanthic ether	$C_4H_5O, C_{14}H_{13}O_3$
Œnanthylic ether	$C_4H_5O, C_{14}H_{13}O_3$
Oleic ether	$C_4H_5O, C_{36}H_{33}O_3$
Opianic ether	$C_4H_5O, C_{20}H_9O_9$

Orsellesic ether	$C_4H_5O, C_{16}H_7O_7$
Oxalic ether	$2C_4H_5O, C_4O_6$
Oxamic ether	$C_4H_5O, C_4H_2NO_5$
Palmitic ether	$C_4H_5O, C_{32}H_{31}O_3$
Pelargonic ether	$C_4H_5O, C_{18}H_{17}O_3$
Perchloric ether	C_4H_5O, ClO_7
Phenic ether	$C_4H_5O, C_{12}H_5O$
Phosphoric ether	$3C_4H_5O, PO_5$
Pyrophosphoric ether	$4C_4H_5O, P_2O_{10}$
Phosphorous ether	$3C_4H_5O, PO_3$
Propionic ether	$C_4H_5O, C_6H_5O_3$
Pyrocitric ether (itaconic ether)	
Pyromucic ether	$C_4H_5O, C_{10}H_3O_5$
Pyrotartric ether	$2C_4H_5O, C_{10}H_6O_6$
Quinic ether	$C_4H_5O, C_{14}H_{11}O_{11}$
Rutic ether	$C_4H_5O, C_{20}H_{19}O_3$
Salicylic ether	$C_4H_5O, C_{14}H_5O_5$
Sebacic ether	$2C_4H_5O, C_{20}H_{16}O_6$
Silicic ether	C_4H_5O, SiO_2
Disilicic ether	$2C_4H_5O, SiO_2$
Suberic ether	$2C_4H_5O, C_{16}H_{12}O_6$
Succinic ether	$2C_4H_5O, C_8H_4O_6$
Sulphocarbonic ether	$2C_4H_5S, C_2O_4$
Disulphocarbonic ether	$2C_4H_5O, C_2S_4$
Trisulphocarbonic ether	$2C_4H_5S, C_2S_4$
Sulphocyanhydric ether	C_4H_5S, C_2NS
Sulphuric ether (true)	C_4H_5O, S_2O_6
Tartaric ether	$2C_4H_5O, C_8H_4O_{10}$
Toluic ether	$C_4H_5O, C_{16}H_7O_3$
Valeric ether	$C_4H_5O, C_{10}H_9O_3$
Xanthic ether (disulphocarbonic ether).	

Detailed information concerning the whole of the compounds of ethyl (except those discovered since the year 1856), will be found in Gerhardt's 'Traité de Chimie Organique.'

ETHYL, used in chemical nomenclature as a prefix, is employed to denote the presence of ethyl in the compound to which the name is applied; thus *ethyl-camphoric acid* denotes camphoric acid containing ethyl. All such compounds will be found mentioned or described under ETHYL.

ETHYLAMINE. [ORGANIC BASES.]

ETHYLENE. (C_4H_4). *Olefiant gas Elayl.* Ethylene is one of the illuminating constituents of coal gas. It is also a common gaseous product of the destructive distillation of other organic substances besides coal; resins, fats, oils, caoutchouc, &c., all yield ethylene when heated in close vessels. When however this gas is required in a state of purity, it is always produced by heating together one part of alcohol and six or seven parts of concentrated sulphuric acid, and conducting it first through a Woulf's bottle containing milk of lime to remove any sulphurous acid, and then through a bottle containing strong sulphuric acid to absorb vapours of alcohol and ether. The reaction by which the olefiant gas is produced, simply consists in a dehydration of the alcohol by the acid, thus:—

$$\underbrace{C_4H_6O_2}_{\text{Alcohol.}} = \underbrace{C_4H_4}_{\text{Olefiant gas.}} + \underbrace{2HO}_{\text{Water.}}$$

but other decompositions occur simultaneously, for the mixture in the generating vessel gradually darkens in colour, and a black gelatinous mass is the final product.

Ethylene is colourless, tasteless, and irrespirable, has a peculiar odour, is of sp. gr. 0·9784, and may be liquified by the combined aid of great pressure and intense cold. It is almost insoluble in water, and but slightly soluble in strong sulphuric acid. Anhydrous sulphuric acid absorbs it in large quantity. It is inflammable, burning with a highly luminous flame. Mixed with twice its volume of chlorine and the mixture ignited, rapid combustion ensues, hydrochloric acid gas is evolved, and a dense cloud of carbon at the same time produced.

Ethylene has the property of combining directly with two equivalents of chlorine or of bromine, iodine, and sulphur, forming the compounds—

Chloride of ethylene	$C_4H_4Cl_2$
Bromide "	$C_4H_4Br_2$
Iodide "	$C_4H_4I_2$
Sulphide "	$C_4H_4S_2$

and recently Dr. Guthrie has described combinations of ethylene with dichloride of sulphur (ClS_2), and with protochloride of sulphur (ClS); the names and formulæ of the compounds being—

Bisulphochloride of ethylene	C_4H_4, S_2Cl
Bichlorosulphide "	C_4H_4, S_2Cl_2

Derivatives of ethylene.—The four equivalents of hydrogen in ethylene may be wholly or in part replaced by chlorine, and four distinct compounds thus obtained. Or they may be replaced by bromine, and to a certain extent by iodine. The names and formulæ of these substitution compounds are—

Ethylene = C_4H_4

Chlorethylene	C_4H_3Cl	Bromethylene	C_4H_3Br
Bichlorethylene	$O_4H_2Cl_2$	Bitromethylene	$C_4H_2Br_2$
Trichlorethylene	$C_4H\ Cl_3$	Tribromethylene	$C_4H\ Br_3$
Perchlorethylene	$C_4\ \ Cl_4$	Perbromethylene	$C_4\ \ Br_3$
Iod-ethylene	C_4H_3I		

Moreover, as with ethylene itself, so with each of the bodies just enumerated, two equivalents of chlorine or of bromine can unite and form a second series of compounds. Such a compound is the chloride of perchlorethylene (C_4Cl_4, Cl_2), or sesquichloride of carbon (C_4Cl_6), while perchlorethylene itself is the protochloride of carbon (C_4Cl_4). [CARBON, *chlorides of*.]

Ethylene combines with anhydrous sulphuric acid, forming crystals of *anhydrous ethionic acid* ($C_4H_4, 4SO_3$). Cold water converts the latter into *hydrated ethionic acid* ($C_4H_4, 4SO_3, 2HO$), which is by ebullition transformed into *isethionic acid* ($C_4H_4, 2SO_3, 2HO$). Ethionic acid is bibasic, isethionic acid monobasic; they both combine with bases to form salts that are mostly crystalline.

Dutch liquid. Ethylene was discovered by some Dutch chemists in 1795. It was called *olefiant* gas, because when brought into contact with chlorine over water the two combined to form a yellowish *oily* liquid that floated on the surface of the water. This oily chlorine compound has always retained the name of *Dutch liquid*, though its true composition ($C_4H_4Cl_2$, chloride of ethylene, mentioned above) is well known. It was the source of that interesting series of ethylene derivatives already enumerated, and has thus greatly aided the advancement of the now well known chemical doctrine of substitution.

ETRUSCAN ARCHITECTURE. We have no remains of Etruscan temples or other important buildings, but we know from ancient authorities that the Etruscans constructed sumptuous public and private edifices; and we can form some idea of their style from their hypogei or sepulchral monuments, and also from some of their cinerary urns which have representations of temples (Micali, plate 72). Vitruvius, although he lived in an age when Etruscan art had undergone considerable alteration, characterises their buildings as "baricephalæ, humiles, latæ," low, wide, with heavy top ornaments. And this seems to be in keeping with the character of the people, grave, and more fond of internal comfort than of external show. What is now called the Tuscan order appears to have been a sort of rude Doric, which they probably adopted from the Greeks, though varying the type considerably. Vitruvius (iv. 7) gives a description of their temples, which appear to have been circular with a single cella, or rectangular with three cellæ; but they could have been neither large nor splendid: the ornaments, bronzes, and plastic figures seem to have been more elaborate than the structures themselves.

The monuments which serve perhaps to throw most light on the subject of Etruscan architecture are the tombs, and especially those at Castel d'Asso, the Axia of Cicero ('Pro Cæcina,' 7), five miles south-west of Viterbo, where the face of a perpendicular cliff forming one side of the valley is sculptured all along for more than a mile with hundreds of fronts or façades of sepulchral monuments, the vaults themselves being excavated underneath. Similar sculptures on the rock are found at Norchia, about 15 miles south-west of Viterbo. (See Inghirami's *plates*.) But there are other of these tombs, which instead of presenting merely a façade cut out of the rock, are entirely detached, the rock being hewn away all round. Occasionally, where the rock is friable, the tomb is built instead of being hewn out of the solid rock. These monuments, which represent a primitive style of Etruscan building, strike by their resemblance to the Egyptian style in its ruder and simpler form. Plate 62 of Micali represents a monument between Monte Romano and Corneto with projecting architrave and lateral pillars. Another kind of tomb consists of a tumulus of earth, the base of which is surrounded by a podium or supporting wall of masonry. Tumuli of this kind remain in immense numbers about the sites of the ancient cities of Etruria. Some of these tumuli are of vast size. The largest, known as the Cocumella, at Vulci, is 240 feet in diameter, and 50 feet high; but is conjectured to have been originally about 120 feet high. This tumulus has near its centre two large towers, one square and the other round. In all these tombs the principal chamber resembles an abode of the living; and when opened has been found to contain biers or bedsteads, vases, and vessels of various forms, shields, weapons, and other articles, often of exquisite workmanship: it is from these chambers that the Etruscan vases found in such profusion in every museum in Europe, have been obtained. The walls of the chambers in the tombs are sometimes panelled, and generally painted with mythic or festive scenes; and around them are seats, with arm-chairs and foot-stools hewn out of the solid rock. The vaulted roofs of these tombs show that the Etruscans were acquainted with the arch from a very early period. They employed the arch also in their gateways, bridges and aqueducts; and in constructing the Cloaca Maxima and other Roman cloacæ.

In the time of Vitruvius the houses of the wealthy Etruscans had external porticoes or vestibula, in which the crowd of servants and clients remained in waiting. The Atrium is supposed by some to be of Etruscan invention. [Atrium.] But of these, as of their civic buildings, we have no vestiges remaining. Of their theatres there are no remains left. Their amphitheatres have also perished, with the exception of one at Sutri; but as this is hewn out of the rock, it can hardly be regarded as a type of constructed buildings of this class. It is 295 feet by 265, and, except in being more circular, differs little from the Roman amphitheatres—which were no doubt formed on the model of those of Etruria. [Amphitheatre.]

The great constructive skill of the Etruscans was especially shown in their massive walls and fortifications, and in their bridges, sewers, and other works belonging to what we now term civil engineering, rather than to architecture. The walls found in the northern part of Etruria are much more rude and massive than those of the south, where the stones, though large irregular blocks, are rudely squared and laid in horizontal courses; in all parts however the stones are laid without cement. They are of the kind known as Pelasgic, but the term is scarcely specific enough, as it does not distinguish any particular class of these walls; or the walls of any particular locality from other walls of the same kind. Some authors however conceive the Etruscans to have been altogether a Pelasgian tribe, and with them the term means that such walls are of Pelasgic origin.

For fuller and more complete information of what is known respecting Etruscan architecture, see Inghirami, *Monumenti Etruschi* (text and plates, series IV.); Micali, *Antichi Populi Italiani,* and *Monumenti Inediti*; Orioli, *Dei Sepolcrali Edifizi dell' Etruria Media;* Abeken, *Mittel Italien;* Müller, *Etrusker;* Lepsius, *Tyrrhenische Pelasgier in Etrurien;* Dennis, *Cities and Cemeteries of Etruria*; Fergusson, *Handbook of Architecture.*)

ETYMOLOGICUM MAGNUM (*τὸ μέγα ἐτυμολογικόν*), an important vocabulary of the Greek language, of which the author is unknown. Some suppose it was written by a grammarian of the name of Magnus. The idea that it was compiled by Marcus Musurus, the first editor, or the Calliergi, is disproved by the fact that this dictionary is referred to by Eustathius. Sylburg considers it as old as the 10th century: much older it certainly was not; for Theognotus, a writer of the 9th century, is quoted in it. The derivations in this work, like most of those attempted by the Greeks themselves, are based upon no principle, and though in some instances accidentally right, they are generally full of the wildest absurdities, as one might expect from the author being confined to mere guess-work. It is valuable however for containing a great many traditions with regard to the meanings of old or uncommon words, and it often enables the scholar to correct the errors of the corrupt but inestimable lexicon of Hesychius. The edition of Sylburg (1594) is very useful, and has an admirable index: the edition of the Etymologicum Magnum, by Schäfer, Lips., 1816, is a reprint of Sylburg's edition. The edition by Sturz, Lips., 1818, 4to., intituled Etymologicum Græcæ Linguæ Gudianum, &c., is founded on the Codex Gudianus, which is more complete than that on which the edition of Musurus and the others already enumerated are based.

ETYMOLOGY. [Language.]

EUCALYNE ($C_{12}H_{12}O_{12}$). A saccharine substance recently obtained by M. Berthelot in the fermentation of melitose:—

$$\underbrace{2(C_{12}H_{12}O_{12})}_{\text{Melitose.}} = 4CO_2 + \underbrace{2C_4H_6O_2}_{\text{Alcohol.}} + \underbrace{C_{12}H_{12}O_{12}}_{\text{Eucalyne.}}$$

Eucalyne is a syrupy unfermentescible sugar, isomeric with melitose.

EUCHARIST (*εὐχαριστία*, thanksgiving) is a Greek name of the Christian sacramental act otherwise called the Communion, or the Lord's Supper; and, in contradistinction from these appellations, it particularly expresses the idea of thankfully commemorating the mediatorial sacrifice of Christ; or, according to others, the name was assigned in reference to the fact that, when Jesus enjoined the observance of the rite, he gave thanks. [Communion.]

EUCHLORINE. [Chlorine, *oxygen and chlorine.*]

EUCHRÖIC ACID ($C_{24}H_4N_2O_{16}$? or $C_8H_3NO_6$). A colourless, crystalline acid, the ammonia salt of which is formed as a bye-product in the preparation of *paramide.* It is distinguished by the production of a beautiful blue colour by contact with metallic zinc. The blue colouring matter thus formed has been termed *euchrone,* but it has not been analysed, on account of the extreme facility with which it decomposes.

EUCHRONE. [Euchroic Acid.]

EUDIOMETER. An instrument employed for the analysis and investigation of gaseous bodies. [Gasometric Analysis.]

EUGENIC ACID. [Caryophillic Acid.]

EUGENIN ($C_{40}H_{24}O_8$?), a substance which deposits spontaneously from the distilled water of cloves; it crystallises in small laminæ, which are colourless, transparent, and pearly, and in time they become yellow. The taste of eugenin is but slight, and the smell much less strong than that of the clove. It is soluble in alcohol and ether in all proportions. By the action of nitric acid, like the oil of cloves, it becomes immediately, even when cold, of a blood-red colour. It appears to be isomeric with Caryophyllic Acid.

EULYTE. A nitrated product derived along with *dyslite,* from the action of nitric acid upon citraconic acid.

EUMENIDES (Εὐμενίδες, the kind goddesses), a name given to the Erinyes, or Furies, a set of goddesses whose business it was to avenge murder, perjury, injustice to parents, and the violation of the rites of hospitality. They were also called Semnæ, or "venerable goddesses," both names being significative of the awe with which the Greeks spoke of the dread goddesses. The name Erinys was derived from the old Arcadian word *erinuein* (ἐρινύειν), 'to be angry.' (Pausan. viii., 25, 6.) These goddesses appear in the play of Æschylus which bears their name, not only as the instruments of wrath and the pleaders for justice against the matricide, Orestes, but also as the promisers of victory, prosperity, and all sorts of blessings to the Athenian people. Their abode, according to the Homeric notion, was Erebus; and they only come upon earth when recalled thither by the devotion of the accursed to their vengeance. Æschylus describes them as having black bodies, snakes twining about their hair, and eyes which dropped blood. Later they were depicted as rather solemn than terrible in aspect; but they continued to have snakes braided in their hair, and to carry them in their hands. The Eumenides are often represented on vases and elsewhere, but never of the terrible Æschylus type. The site of the temple of the Eumenides at Athens, where their worship possessed a peculiar importance, was the north-east angle of the Areopagus, at its base. "There is a wide, long chasm there, formed by split rocks, through which we enter a gloomy recess. Here is a fountain of very dark water." (Wordsworth's 'Athens and Attica,' p. 79.) The Athenians sacrificed to the Eumenides, among other victims, black sheep: no wine was mixed up with the libations offered to them, but only oil, honey, and water, in three separate libations, out of different vases. (Soph., 'Œd. Col.,' 469, &c.) Of the number of these goddesses we have contradictory accounts; in the play of Æschylus it is pretty certain that there were fifteen in the chorus. By later writers their number is more limited, some making them to be only three in number; and their names Alecto, Megæra, and Tisiphone. (Müller's 'Eumenides,' § 10.) Every question connected with these divinities is accurately and satisfactorily discussed by Müller in the second essay at the end of his edition of the 'Eumenides,' §§ 77–93. See also Böttiger's 'Furienmaske,' and Millin's 'Orestéide.'

EUNUCH (*εὐνοῦχος, eunúchus,* literally, 'one who has the care of a bed'). The Greek word may be considered as descriptive of the functions of those who were made eunuchs, it being usual among the Persians to entrust the care of their wives and daughters to such persons. It does not appear that eunuchs were made by the Greeks; this peculiar species of barbarity was a Persian practice (Herod. vi. 32); though the Greeks sometimes carried on the trade of making eunuchs, whom they sold at Ephesus and Sardis to the Persians for high prices, the Persians considering that eunuchs generally were more trustworthy than other men. (Herod. viii. 105.) Tavernier tells us that in the kingdom of Bootan 20,000 eunuchs were annually made in his time to sell to other nations; and the seraglios of the East are principally served and guarded by them to the present day.

The Christian emperors of Rome forbade the practice of making eunuchs, particularly Constantine; and Justinian imposed a law of retaliation upon such as exercised this inhumanity. In Italy, however, the process of castration was much more recently practised upon children intended to supply the operas and theatres of Europe as singers. The Council of Nice condemned those who from excess of zeal made eunuchs of themselves. Persons so mutilated were not admitted into holy orders. The reader who would know more on this subject may consult the 'Traité des Eunuques,' 12mo, 1707, by M. d'Ancillon.

Certain heretics of the 3rd century bore the name of Eunuchs who had the folly or madness, after the example of Origen, not only to castrate those of their own persuasion, but all whom they could lay hands on. They were also called Valesians, from Valesius, an Arab, who was their chief. (See Epiphanius and Baronius's 'Annals,' under the years 249 and 260.)

EUPATORINE. An alkaloid of unknown composition, contained in the *Eupatorium cannabinum.*

EUPHORBIC ACID. A crystalline acid of unknown composition, said to be contained in the *Euphorbia cyparissias.* Its existence is doubtful.

EUPHORBIUM, improperly called a gum, or gum-resin, since it is entirely destitute of any gum in its composition, is the concrete juice of several species of euphorbia, either exuding naturally or from incisions made in the bark, therefore properly a cereo-resin. Much of the article found in British commerce is obtained from the *Euphorbia Canariensis,* while that which occurs on the Continent is obtained from *Euphorbia officinarum* (Linn.) and *E. antiquorum* (Linn.), and other African species, particularly from an undescribed species, called by the Arabs *dergmuse.* The branches of this plant are used in tanning, and to it, according to Mr. Jackson ('Edinburgh Medical and Surgical Journal,' vi. p. 457), the morocco-leather owes its peculiarities. By the most recent chemical analyses, euphorbium seems to consist of resin, wax, and saline matter (mostly malates). The resin is the active principle, and differs in some respects from most other resins, particularly in its less solubility in alkalies.

Euphorbium is a powerfully acrid substance, causing irritation and inflammation of the parts with which it comes in contact, and by sympathy affecting the nervous system. The dust received into the nostrils or eyes occasions violent sneezing and lachrymation, or even more serious affections of the eyes, so that it is necessary for those who grind this drug to protect the face by masks. Delirium and stupor approaching to apoplexy have followed the inhalations of the dust. When swallowed, it causes, in small doses, vomiting and purging; in larger doses it produces inflammation of the stomach, and sometimes proves fatal. It is now little used, even as an external application to produce vesication or ulceration, except by veterinary surgeons, and even by them cautiously. It is sometimes used as an errhine, largely diluted with starch, and enters into the composition of some cephalic and eye-snuffs; but it is apt to be violent in its effects. In case of poisoning by it, demulcent or oily fluids should be given, and venesection employed if much inflammation ensue.

EU'PION, a liquid obtained by Reschenbach from vegetable tar, especially that from beech-wood. The process for procuring it is operose and complicated. Its properties are—that it is very limpid, colourless, inodorous, and tasteless; it boils at about 117° Fahr., and distils unchanged; it remains fluid at 4°. It is insoluble in water, but dissolves in alcohol, oil of almonds and of olives, oil of turpentine, naphtha, &c.; it dissolves chlorine and bromine, which are evolved when it is heated, and it also takes up camphor, stearin, and naphthalin, at common temperatures, but when heated, in larger quantity; with iodine it forms a blue solution. It dissolves phosphorus, sulphur, and selenium when heated, but the greater portion is deposited on cooling. Caoutchouc swells in it, and when heated dissolves. It is not altered either by exposure to air or by acids or alkalies. It probably consists chiefly of hydride of amyl, or a mixture of the hydrides of the ethylic series of radicals.

EUXANTHIC ACID ($C_{42}H_{17}O_{21},HO$). *Purreic Acid.* There is a yellow or brownish matter met with in commerce under the name of *purrée*, or *Indian yellow*. It is imported into Europe from the East Indies, but its origin is involved in obscurity; by some it is supposed to be a deposit which forms in the urine of the camel, the elephant, or the buffalo; by others it is believed to be an intestinal concretion of some animal. This material, whatever its origin, consists principally of the magnesia salt of a peculiar acid, to which the above name has been given. This acid is extracted by washing the Indian yellow with boiling water, and then dissolving it in boiling dilute hydrochloric acid. On cooling, this solution deposits pale yellow crystals of euxanthic acid.

Euxanthic acid is very slightly soluble in boiling water, but very soluble in boiling alcohol. Cautiously heated in a narrow tube, euxanthic acid decomposes and forms a yellow sublimate, consisting of *euxanthone*, or *purrenone*:—

$$\underbrace{C_{42}H_{18}O_{22}}_{\text{Euxanthic acid.}} = \underbrace{C_{40}H_{12}O_{12}}_{\text{Euxanthone.}} + 2CO_2 + 6H\dot{O}$$

With the exception of the salts of the alkalies, the euxanthates are mostly insoluble in water.

Treated with chlorine, bromine, nitric acid, or sulphuric acid, it yields substitution products, of which the following are the names and formulæ of the principal:—

Bichloreuxanthic acid . . .	$C_{42}H_{16}Cl_2O_{22}$
Bibromeuxanthic acid . . .	$C_{42}H_{16}Br_2O_{22}$
Nitreuxanthic acid	$C_{42}H_{17}(NO_4)O_{22}$
Hamathionic acid	$C_{32}H_{14}O_{24}S_2O_6$?

Euxanthone yields similar substitution products:—

Trichloreuxanthone . . .	$C_{40}H_9Cl_3O_{12}$
Tribromeuxanthone	$C_{40}H_9Br_3O_{12}$
Porphyric acid	$C_{20}H_4(NO_4)_2O_8$?
Oxyporphyric acid	Unknown.

EUXANTHONE. [EUXANTHIC ACID.]

EVANGELIST is the Greek appellation *Euangelistes* (εὐαγγελιστής, from εὐ and ἄγγελος), which signified a messenger of any good news, as in Isaiah xli. 27, of the Septuagint version. In the first ages of Christianity it was a general name of all those who, either by preaching or writing, announced the "glad tidings" of the Christian revelation. The learned Hooker, in his 'Ecclesiastical Polity,' b. v. § 78, says that "Evangelists were presbyters whom the Apostles sent forth and used as agents in ecclesiastical affairs." They were similar to the class of ministers who in modern times are known as itinerant preachers. The deacon (subordinate minister) Philip is called an evangelist (Acts xxi. 8; see Grotius on the passage); so Ananias, Apollos, Timothy, and several others. St. Paul, in his epistle to the Ephesians (iv. 11), places evangelists in the third rank of ecclesiastical officers; thus, apostles, prophets, evangelists, pastors, teachers. Mosheim says the name was applied to all those, in the infancy of the Church, who had received the gift of tongues. The use of the term is now confined to the four writers to whom the canonical gospels are attributed,—Matthew, Mark, Luke, and John,—and the gospels themselves are not unfrequently, though incorrectly, called the Evangelists. St. Jerome states that the symbols of the four evangelists are a man, a lion, a calf, and an ox; but St. Augustine declares them to be a lion, a man, an ox, and an eagle. (Ezekiel, i. 5–10; Rev. iv. 7.) Dr. Campbell, in his 'Dissertation on the Gospels' (vol. i., p. 126, &c.), gives a variety of learned and critical remarks on the word εὐαγγελίζειν, as the translation of the Hebrew בשר, *bashar*, 'læta annunciare,' 'to announce good tidings.' (See the word in Rose's ed. of Parkhurst's 'Gk. Lex. of the N. T.')

EVAPORATION is the transformation of liquid, and in some cases of solid substances into a gaseous state by the action of heat. According to circumstances the effect may take place slowly and without any apparent movement of the surface of the liquid from which the vapour rises, or it may take place rapidly, and be accompanied by an ebullition. In the latter case, however, the process is termed *vaporisation*. [BOILING OF FLUIDS; EBULLITION]. In the process of evaporation, electricity has some share, as will be noticed further on.

If a liquid be placed in an open vessel, it will be found gradually to diminish in quantity by a sensible or insensible evaporation, and it will at length disappear: the quantity of vapour proceeding from the same liquid in a given time is evidently proportional to the area of the exposed surface; but, with equal temperatures, the escape of vapour from different liquids will be found to take place with different degrees of rapidity. An evaporation of the waters at the surface of the earth is going on at all times, and over the surface of an ocean the aqueous vapour held in the atmosphere amounts to an enormous quantity: much of this vapour is precipitated to the earth in the form of dew, rain, &c., but it is probable that the atmosphere, at any place, is never entirely free from it.

The whole quantity of vapour which rises from a liquid having a given surface appears to depend upon the temperature of the liquid; but, in a given time and in the open air, it is influenced by the state of the atmosphere with respect to dryness or moisture: in dry weather, even in winter time, the evaporation is more considerable than in damp weather, but it is greatest when the atmosphere is both dry and warm. At equal temperatures, in a close vessel, the evaporation is the same whether the vessel containing the liquid contain also air or have the air exhausted from it; but in the latter case the quantity of vapour which a given degree of heat is capable of raising occupies the upper part of the vessel immediately, whereas in the former a certain time elapses before that quantity is disengaged.

In order to obtain a knowledge of the quantity of water evaporated in the open air, in a given time, the atmosphere being calm, Dr. Dalton suspended some in a cylindrical vessel of tin from one end of the beam of a balance, and raised it successively to different degrees of temperature by heat: he weighed the water before and after each experiment, during the continuance of which the temperature was constant; and the difference divided by the number of minutes gave, for that temperature, the weight of the water evaporated in one minute from the exposed surface. At the boiling-point (212° Fahr.) the evaporation of water from one square inch of surface was found to be equal to 4·244 grains per minute, and at a temperature expressed by 138° one grain per minute: between these limits the quantities of the evaporation, per square inch, in grains, are nearly proportional to the heights, in inches, of the columns of mercury, whose weights are equivalent to the elastic forces of the vapour at the different temperatures.

In these experiments no allowance was made for the effects depending on vapour previously existing in the atmosphere, these effects being very small compared with the elastic force of the vapour rising from the water at such temperatures. But Dr. Dalton, taking f to represent the elastic force of vapour in the atmosphere when at the point of saturation, and f' to be the elastic force of the vapour in the actual state of the atmosphere, the temperature of the air in both cases being that which is indicated by the thermometer at the time of the experiment, found that the quantity of evaporation from a square inch of surface, at such temperature, was proportional to $f-f'$, and might be expressed by $\frac{4\cdot 244}{30}(f-f')$. ('Manchester Memoirs,' vol. 5.) The evaporation from ice has been determined by experiment both by Dalton and Gay-Lussac, and was found to be equal in quantity to that which, by computation, would take place from water at the same temperature.

To Dr. Dalton we owe also the discovery, admitting however that the aqueous vapour in the atmosphere has no influence on evaporation, that the quantity of vapour raised from a given surface of any liquid, at a given temperature, is directly proportional to the elastic force of the vapour at that temperature; therefore, if the elastic forces of the vapours from different liquids were correctly ascertained, a near approximation, at least, might be made to the amount of evaporation from those liquids. At a temperature equal to 212° (Fahr.) the elastic force of the vapour from water is equivalent to the weight of a column of mercury 30 inches high; the elastic force of the vapour of one kind of alcohol, to the weight of a column 68 inches high; and that of the vapour of one kind of ether, to the weight of a column 219 inches high.

It is stated by Mr. Faraday that, at temperatures above 60° or 80° Fahr., there is a small evaporation from mercury; at lower temperatures he could detect none; and he concludes that, below the temperatures just mentioned, the gravity of the particles of mercurial vapour exceeds their elastic force. In this material, as well as in all liquids which boil at high temperatures, the elastic force of the vapour is very small. Sulphuric acid, for example, boils at 640° Fahr., but it emits no vapour at ordinary temperatures. Most solid substances have vapours of such low elasticities, that the highest natural temperature cannot convert them into vapour: and hence Mr. Faraday concludes that the atmosphere does not contain any vapours of earthy or metallic substances. Camphor evaporates readily at ordinary temperatures, and deposits crystals on that side of the glass vessel which contains it which is nearest to the light. When ice is introduced into the Torricellian vacuum it immediately depresses the mercurial column upwards of $\frac{18}{100}$ths of an inch. This is at 32°, but even at zero the tension of the vapour of ice amounts to $\frac{4}{100}$ths inch: it is in consequence of this evaporation that drifts of snow and patches of ice disappear even during the continuance of severe frost.

A few cases occur in which a body passing from a liquid to a solid form acquires thereby an increase of temperature, and the most remarkable case is afforded in the freezing of water. While still existing in a liquid state, water has had its temperature reduced so low, that a Fahrenheit's thermometer in it indicated no more than 5°; but on being made to crystallise, by agitation or otherwise, so much caloric was immediately evolved, that the thermometer rose to 32°. But when, by evaporation, a liquid is transformed into a vapour, heat is abstracted, and a thermometer in the liquid indicates a depression of temperature, or the liquid becomes cooled. In some parts of India, ice is produced by exposing water during the night in flat unglazed earthen vessels resting upon any imperfectly conducting substances, as sugar-canes, dry stems of maize, and the like. The dryness of the air allows a considerable evaporation to take place, and a thin film of ice is produced. Similar processes are employed in other countries for the purpose of reducing the temperature of liquids. [Cooler.] To a similar cause must be referred the icy caverns of the Jura, of Connecticut, and of Illetzkaya in the steppes of the Kirghis; namely, the powerful evaporation of moisture caused by the vicinity of the warm and dry external air.

The pressure of the atmosphere on the surface of a liquid may retard but does not prevent the evaporation from taking place. Vapours, like gases, mix with other aëriform fluids according to their own laws, and as if they were diffused through a vacuum. Each atmosphere of vapour in the compound atmosphere acts on its own particles alone; so that the aqueous vapour in the atmosphere acts by pressure only on itself. The time that is occupied before a given space is saturated with a vapour varies inversely with the pressure; and with different vapours, under the same pressures, the time varies with the diffusiveness of the vapour. [Diffusion.] The conversion of a liquid into a vapour is facilitated by placing the vessel containing the liquid under the receiver of an air-pump and extracting the air: but the vapour itself acts by its elastic force on the surface of the liquid, and impedes, at least for a time, the escape of more than a certain quantity. Daniell found that when water was evaporated under the receiver of an air-pump in the presence of sulphuric acid, the rate of evaporation was inversely as the pressure. Consequently the cooling process may be greatly accelerated by employing some means of absorbing the vapour as fast as it is formed, thus allowing the evaporation to go on without impediment. The means of accomplishing this end were discovered by Sir John Leslie, who placed a shallow open vessel containing sulphuric acid or muriate of lime along with the vessel containing the water from which an evaporation was to take place under the receiver of the air-pump; when the vapour was absorbed as it rose, and the water was speedily converted into ice. [Freezing Apparatus; Cryophorus.]

If a glass bottle containing water be covered with a cloth which is kept constantly wet by the application of water, the evaporation from the wet cloth will soon diminish the temperature of the water which is in the bottle. A similar effect is produced, but in a higher degree, on moistening the bottle with some spirit, as alcohol; and if a cloth dipped in alcohol be applied to the ball of a thermometer, the mercury in the tube will descend while the evaporation continues: the cooling is found to be so much greater as the spirit is more volatile; and it appears to be the greatest when ether is employed.

The degree of cold thus produced is increased by any means which will accelerate the evaporation: thus, by wrapping a piece of linen dipped in ether round the ball of a mercurial thermometer, and exposing the apparatus to a current of air, the mercury in the tube has been made to fall as much as 45°. Dr. Cullen ('Essays, Physical and Literary'), of Edinburgh put a small quantity of water into a thin glass tube which was suspended in a vessel containing ether; and then, on placing the apparatus under the receiver of an air-pump and rapidly exhausting the air, the evaporation of the ether caused such a diminution of heat in the water that it was converted into ice. By a similar process, using sulphuret of carbon instead of ether, Dr. Marcet ('Phil. Trans.,' 1813) succeeded in freezing mercury. Still more remarkable cases are given under Ebullition.

For the method of ascertaining the amount of moisture in the air under any given temperature, see Hygrometer. The supposed connection between evaporation and electricity is noticed under Electricity, Atmospheric; and the importance of evaporation as a meteorological agent will be further considered under Rain; Meteorology, &c.; but we may here refer to the old opinion advocated by the Abbé Nollet and others, that "electricity increases the natural evaporation of fluids," and that it is more efficient in this respect when the vessels which contain them are conductors. Mr. Rowell ('Cause of Rain,' Oxford, 1859) suspended by means of silk threads, in a warm room over an oven in daily use, two shallow vessels each containing 8 ozs. of water. From one of the vessels was hung a small copper wire passing from the water to the earth. In the course of twenty-five hours the insulated vessel lost 2 ozs. 11 dwts. 15 grs., and the other vessel 3ozs. 6 dwts, thus showing an excess of evaporation from the non-insulated vessel of 14 dwts. 9 grs. A similar result was obtained when the vessels were exposed to the sun.

EVECTION. [Lunar Theory.]

EVERITT'S SALT. [Cyanogen, *diluted hydrocyanic acid.*]

EVERNESIC ACID. Synonymous with Everninic Acid.

EVERNIC ACID ($C_{34}H_{16}O_{14}$?), a crystalline acid, homologous with lecanoric acid, extracted from a species of lichen, the *Evernia prunastri.* [Lichens, Colouring Matters of.]

EVERNINIC ACID. [Lichens, Colouring Matters of.]

EVIDENCE (Judicial) denotes, in jurisprudence, the proper means of evincing the true state of facts which have become the object of judicial investigation; and the just use of such means for that end in these investigations is the proper object of those established rules which are received in the courts of justice as the law of evidence. This law originates in the practice of the tribunals, continues into the latest times for the most part still unwritten, and long retains the character of the age which conceived and formed it for immediate service. Gradually the course of ages, changing the manners and continually adding to the moral and intellectual wealth of the nation, brings with it the necessity at length of departing somewhat from the tradition of the fathers. Reforms are introduced by positive enactment, and other reforms succeed as confidence increases with experience of the improvement effected thereby in the administration of justice. In this way our statute-book comes to exhibit at distant intervals the traces of change, which might be studied with advantage, relative to the history and character of the nation, but from which little information could be derived respecting the principles and rules that constitute this branch of English jurisprudence. The great bulk of these remain at this day, as they have been for ages, the subject of tradition, the common law of the courts, the familiar rules of daily practice in the administration of justice. But we are apt to forget this when we turn to Justinian's 'Digest,' and point with something like contempt to one short chapter which appears there, as though it necessarily comprised all that was known to the Roman law on the subject of evidence. This is probably an error of the same kind with his who should assume that in the fragmentary provisions of our statute-book he finds the whole of the English law upon the same subject; but the wrong would be so much greater, as it is done to the memory of a people whose jurisprudence has been the light of modern nations and the cherished wealth of the greatest minds, and which for its wisdom and rectitude still secures them the position and authority of the masters of the world.

Judicial evidence, considered with regard to its sources, is derivable from living witnesses, and from written instruments; and viewed with respect to its production in court, and admissibility as the means of judicial inquiry, it is subject to conditions which in the order of things demand our earliest attention.

The first great condition of the admissibility of living testimony in this country is that it must be given under the sanction of an oath. It suffices, however, that it be such an oath as is binding on the conscience of the witness. No exclusive ceremony or form of words is prescribed by our law, and no further inquiry into the faith of the witness is permitted than is necessary to ascertain whether he acknowledges the existence and moral government of the Divine Being, and that he will punish falsehood and perjury, either in this life or that which is to come. Even that inquiry is not volunteered by the judge, though it is permitted to be made by the adverse party; for it is a presumption of law that every person, in this country, of sufficient mental capacity, entertains this faith, and the usual form of oath is tendered without preliminary question. But obvious incapacity of mind, whether it be the immaturity of young children or the defect of the insane, rebuts this presumption of the law, and imposes on the court the duty of making previous inquiry into the state of the witness's knowledge with regard to the nature of an oath.

The exemption, at an early period, from this necessity, of certain religious sects who entertain conscientious objections to oaths of any description, has recently been extended to all persons who allege conscientious motives for their refusal or reluctance to take the oath. This is a modification, still in the spirit of the general rule, rather than any exception to it, made in favour of tender consciences which are hindered from following the common practice by a scrupulous and reverent obedience to what they regard as the Divine Will.

Scarcely more an exception than this is the admission in evidence upon trials for homicide of the dying declaration of the injured person, who in that condition makes a statement unsworn of the circumstances under which he received his injury. These statements, says Lord Chief Baron Eyre, "are declarations made in extremity when the party is at the point of death, and when every hope of this world is gone; when every motive to falsehood is silenced, and the mind is induced by the most powerful considerations to speak the truth; a situation so solemn and so awful is considered by the law as creating an obligation equal to that which is imposed by a positive oath in a court of justice."

The production of written instruments as evidence upon a judicial inquiry must be accompanied with proof of due execution under the hand or seal, or hand and seal, of the parties thereto; and such proof ought properly to be by the attesting witness, if the witness be alive and can be found, and if it be in obedience to the law that such attestation appears to the instrument.

The effect of this general condition had been superseded by the early practice of the courts in respect of the seals of certain public offices and well-known officers, of which the judges took judicial notice, dispensing with the evidence required in other cases; and this with so much convenience to the suitors, and saving of needless expense, and without any experience therefrom of counterbalancing disadvantages, that the legislature, by the Documentary Evidence Act (8 & 9 Vict. c. 113), made all documents of any public company, which are evidence by force of any statute, admissible in evidence, if they purport to be sealed or impressed with a stamp, or sealed and signed, or signed alone, or impressed with a stamp and signed, as the particular statute may require, without further proof of execution. The same statute extends this favourable exception to other classes of seals and signatures, and it has been followed to the same purpose by subsequent statutes, particularly the General Evidence Act (14 & 15 Vict. c. 99), and the Chancery Practice Amendment Statute, of the same year (14 & 15 Vict. c. 86).

The brevity of human life has imposed on the courts the necessity of making another exception to this general condition in favour of ancient writings, which are admitted in evidence without proof of execution after thirty years from the date thereof, provided they appear, upon testimony, to have been produced from the custody in which it is reasonable to expect, if genuine, that they would be found.

Besides these general conditions of the admissibility of living testimony and written evidence, certain other exclusive limitations thereto, which have exercised a powerful influence on the administration of justice, still require to be noticed. Living testimony was liable, till within a very recent period, to be shut out on the ground of the *incompetency*, as it was called, of the person to give evidence. A person might be incompetent because he was interested in the matter in question, or in the event of the trial, or because he had been convicted of an infamous crime. These grounds of exclusion, abounding with injustice, and scarcely possessing a single recommendation, have at length been abolished. The immediate parties to the suit or action are consequently admissible witnesses in any proceedings, except proceedings in consequence of adultery, or for breach of promise of marriage, or the defendant in criminal proceedings. A husband and wife, so constantly regarded at common law as one person, are now competent and compellable to give evidence, although it be for or against each other, in any proceeding, except a criminal proceeding when one of them is defendant, or a proceeding instituted in consequence of adultery. Neither of them, however, is compellable to disclose any communication made to the one by the other during the marriage; and generally no person is compellable to answer any question if the answer to it would have the effect of criminating the witness, or the husband, or wife of the witness, respectively.

Available evidence, in the nature of written documents, is often excluded by the immediate operation of the revenue laws, when the parties have neglected to use the stamp appropriate to the instrument produced. This is now so far modified in many cases as to enable the parties to give the instrument in evidence on payment in court of the stamp-duty and a fine, provided it is not one of those instruments (such as bills of exchange) which the law does not permit to be subsequently impressed with a stamp.

There is also a numerous class of facts of which it is the policy of our law to exclude all evidence except it be of one description. Some facts, for instance, are proveable only by the record of a court of record; others by writing under the seal of the parties; others by writing under the hand of the parties, in the presence of attesting witnesses; and others, again, by writing under the hand of the parties merely. Of such facts, if the proper evidence required by law, duly drawn up and executed, has ever at any time existed, we shall see that in virtue of another rule of evidence, proof of a secondary order is admissible upon showing the loss or destruction of the original instrument. But if no such original evidence ever has been in existence, the facts themselves, although their existence may be otherwise credibly attested, are not proveable in a court of law.

Evidence, again, which would be of the most cogent effect if it were accepted, is often so tainted in its origin, that it is not merely worthless, but absolutely inadmissible. Instruments which in their contents are most relevant to the inquiry, and have been to all appearance duly executed by the parties, may have been forged, or executed under duress, or in such a condition of mental incapacity that the person circumvented could not be held to be *compos mentis*. Again, a confession of guilt is popularly regarded as superseding the necessity for further inquiry; and this is not a modern opinion merely. *Reum confitentem habete*—used to resound in the Roman Forum as conclusive to the minds of the *judices*. The most experienced of our English judges, however, have learned to regard such evidence with anxiety and distrust; and, accordingly, when the confession is obtained under a promise or a threat by one who seemed to possess the power of giving his words effect, our law, with a commendable tenderness for human infirmity under circumstances so painful, rejects the evidence as too tainted in its origin to be deserving of credit, and too dangerous to innocence to allow of its being submitted to a jury. When the confession is perfectly voluntary it is admissible, but only as against the person who made it. As against all others it is worthless,—the law entertaining a jealous dread of the feeling of revenge in a malignant mind, and the cruel devices to which that passion has recourse for gratification. But this does not prevent an accomplice being made a witness, although he necessarily thereby criminates himself; for his evidence is no longer confession merely, but evidence given upon oath, and subject to cross-examination by the adverse parties. Again, of that description o. evidence called *hearsay*, which is admissible on certain questions of a public and *quasi* public nature, only that is admissible which can be shown to have originated *ante litem motam;* for it is obvious that, after the question at issue definitely emerges into public view between opposing interests, even people who are not directly concerned themselves, or in any way tampered with by the parties who are, yet are so liable to be moved by considerations that bias the mind and colour the testimony, that their sayings, although the authors are since dead, uttered under such influences, unsworn, and subject to no cross-examination, are excluded as mere sources of error and destitute of credit.

This is a compendious view of the operation and grounds of the general conditions upon which the admissibility of evidence by the law of this country depends. Those general rules descriptive of the evidence itself, and demonstrative, among all that is admissible, of that only which ought to be produced, come now to be stated with similar conciseness.

The first of these rules requires that the evidence should be relevant to the points actually in issue between the contending parties. To ascertain and exhibit these points is the principal office of the record. The sole purpose of what is technically termed pleading, is to reduce the dispute between the litigants to one or more definite and simple propositions, affirmed on the one hand and denied on the other, concerning the same subject, and in the same respect. The parties are then said to be at issue. One of the greatest of those evils which had crept into the system of pleading, and corrupted it from its original intention, had gone far, by means of what is called the general issue, to frustrate the chief purpose of the record as the authentic account of the precise matters in difference, and the determinate rule of the Nisi Prius evidence. The general issue, a quarter of a century ago, was a denial of the statement of the cause of action, so indefinite as to give the defendant the choice of several courses at the trial, and the plaintiff no notice what defence he was to meet, until the instant that he was called on to produce rebutting evidence. Together with the loss, in this way, of the substantive benefit of pleading, there was also such an increase of attention to matters of mere form, that it had become a refined subtlety and an elaborate snare. The great object of the new rules of pleading was to secure definiteness and simplicity, and singleness in the issues on the record; and since the publication of these rules, although the general issue still remains in name, and perhaps in form, yet, with the exception of some cases reserved by statute, it is now so defined and restrained by these same rules, that relevancy in the evidence is with much reason required, and always with great propriety very strictly enforced.

It is impossible here to omit all mention of a rule which writers upon evidence discuss at great length in their treatises, as though it formed an integral part of their subject. This rule requires that the evidence produced at the trial should correspond with the allegations placed on the record. It is plain to common sense that this is a rule of great importance to the suitor. It is clear that a person who alleges one thing on the record and produces something very different in evidence at the trial, cannot hope to succeed with either, unless there be an amendment somewhere to reconcile the difference. But then it is clear also that the proper evidence in the case never can admit of any tampering, paring, and altering; and as the allegations on the record may well be amended to meet the state of facts proved at the trial, it seems to follow that this is a rule of pleading rather than of evidence.

The evidence relevant to the issues admits of a distinction into primary and secondary; and this distinction forms the basis of another general rule, which requires the suitor to produce the best evidence of which the subject is susceptible. We have already seen that the law, for reasons not necessary here to be considered, requires some transactions to be reduced into writing and signed, others into writing under hand and attested by witnesses, and others into writing under seal; and where writing is not required, but the parties of their own accord have given this permanent form to their meaning and intentions, the law accepts this as the more certain and therefore better evidence of the transaction. In these several instances, the original writing forms what is termed in the rule the *best* evidence of the transaction which constitutes the contents of the document; and if suitors might at will produce it, or offer other evidence of its contents, whether oral or written, a ready opportunity of fraud would exist which the suitor at a push might be in great temptation to use. While the original writing exists, therefore, it is the only admissible evidence of its contents, unless it be withheld by the other party to the action. In that case, or in case it be lost or destroyed, secondary evidence is then receivable; and, as there are no degrees of superiority in secondary evidence, this may be either oral or written.

A numerous list of exceptions to this rule has been created by statutory provision, making examined or certified copies of various public documents, registers, and legal proceedings, evidence of the contents of the originals; and so much has public convenience been consulted by this exception, that parliament consented to the insertion of a general provision in the Evidence Act (14 & 15 Vict. c. 99), greatly extending the range of this privilege.

It is often laid down as a distinct rule in the law of evidence that parol testimony is not admissible to contradict, vary, add to, or subtract from the terms of a valid written instrument. This, if not a branch of the rule in respect of best evidence, certainly follows that other with the necessary sequence of a corollary, and is its proper complement.

Upon this rule also the imperfection attending human transactions has forced several exceptions. It is clear that instruments containing technical words used technically, or common general words used in a peculiar and local sense, and contracts so drawn up as to leave unexpressed, but intentionally implied, the usages of a particular trade, or the customs of an ascertained locality, would be misconstrued, if construed at all, without parole evidence of such use, usages, and customs. But if the effect of such parole evidence when given be inconsistent with the terms of the writing, the new matter will be rejected by the court, as being expressly excluded by the document, and this will be construed without extraneous assistance, as containing the full expression of the intention of the parties. Evidence of any subsequent agreement of the parties is only admissible to contradict or vary a written instrument when it is in a form of equal solemnity with that which is required by the law in respect of the instrument to be varied or contradicted. Parole contradictions, or additions to any written instrument whatever, are altogether inadmissible when contemporaneous with it. But this rule does not shelter fraud or illegality, so as to debar from proving it by oral testimony; it does not exclude verbal evidence of mistake when relief therefrom is sought in equity; it does not shut out proof of the want of consideration for bills of exchange, because that is only a presumption of law in their favour, and is not expressed in the writing.

It is a rule of evidence that *hearsay* is inadmissible as evidence on matters of private interest between party and party. By the rule requiring testimony to be given under oath, such evidence as this would be excluded, but not by this rule only. The uncertainty, first, of what was said or done; secondly, of what was meant thereby; and thirdly, whether the full meaning and entire truth were conveyed by the words or acts, or both acts and words spoken to, must be a sufficient ground for excluding this kind of evidence. Yet here too we are obliged to take notice of a number of exceptions.

In cases of homicide, and these only, although greater scope was given to it in earlier times, exception, we have seen, is now made in favour of the dying declaration of the injured person, when the circumstances of the injury are the subject of the statement. The apprehension of death, followed afterwards by that event, is an indispensable condition of the admissibility of the declaration, as forming an equivalent to the sanction of an oath. And considering that the events are likely to be recent, and the impressions of them painfully emphatic, whilst the words of the statement are naturally presumed to be sobered down to the truth by the solemn apprehensions of approaching dissolution, it is not unreasonable to believe that such a declaration satisfies the adjuration addressed to all witnesses, and states the truth, the whole truth, and nothing but the truth, touching the matter in question. But if the declaration be such, that it appears to be incomplete, and that a modification was intended but not expressed, it will not be received in evidence.

Another exception to the rule is made in favour of entries in books against the pecuniary or proprietary interests of the person who made them, and is since dead. It was contrary to his interest to have made them at the time, and it is essential to this admissibility that death should have previously removed him from all possibility of personal interest in the use of them as evidence. There is this, however, which is remarkable about the effect of such entries, that they are admitted as evidence, not only of the fact which forms the main purpose of their existence, for instance that a pecuniary claim has been satisfied, but of what is incidental thereto, for instance of the facts on which the claim itself was grounded.

Entries made in the course of business or the routine of office, when they are contemporaneous with the events which they record, and the person who made them is since dead, form another exception to the general rule excluding hearsay as evidence. But these entries, unlike those already referred to, are evidence only of that which it was the business of the person making them, to record, and more. The routine of business, the absence of sinister motives, the cognisance which others have of the same facts and entries operating on such a person as a check, and the powerful interest which he usually has in being correct, form together no weak argument for the admissibility of such evidence. The effect of it when admitted will be indefinitely varied by the existence or absence of corroborating circumstances.

Another general exception to this rule admits *hearsay* as evidence on questions of public and quasi public interest. In this general description we include such matters as a claim of a public highway, right of common *pur cause* of vicinage, manorial customs, and questions of pedigree, which when once involved in doubt, either from the absence of written documents, or the ambiguity of their contents when they exist, are scarcely susceptible of any other description of evidence. Even in these cases, however, the evidence admissible is not hearsay indiscriminately originated in any quarter, or at any period of time. We have already ascertained the limit placed upon it in respect of time. And in respect of source, it is only those, whose interest in the claim or right engaged them to inquire, and gave them opportunity of knowledge on the subject, that are recognised as competent to be authors of this kind of tradition which the courts are obliged to receive in such cases. The effect of that rule is to define the circle, from which hearsay is derivable, by the range of legal interest possessed in the matter in question, so that in pedigree cases, for instance, the tradition of blood-relations only is receivable in evidence. This kind of interest which is thus recognised by the law as the condition on which depends the admissibility of hearsay, would entirely derogate from the worth of the evidence when admitted, if that other rule which has been referred to did not exclude all hearsay originated at a period subsequent to that when the right or claim began to emerge as a matter in difference.

We have thus offered a compendious view of the chief principles and rules of the English law of evidence, and for further details and a full discussion of the subject we must refer to such writers as Taylor, Phillips, Greenleaf, Best, and Starkie.

EVIL EYE. It was an ancient superstition that certain persons were endued with the power of injuring those on whom they cast a hostile or envious look. The eyes of such persons were supposed to dart noxious rays on every object on which they were fixed. This power of injuring with the eye was called *Bascania* (Βασκανία) by the Greeks, and *Fascinatio* by the Romans. Plutarch 'Symposiacs,' lib. v. quest. 7, states, on the authority of Philaretus, that the Thybiens who inhabited Pontus were deadly, not only to babes, but to men grown, and that whomsoever their eye, speech, or breath, would reach, were sure to fall sick and pine away. Several writers who have collected the testimonies of the ancients concerning it (as Potter, 'Archæologia Græca,' lib. ii. c. 18, and Alsarius, 'De Fascino,' in 'Grævii Antiq. Rom.,' tom. xii. p. 885), may be consulted for particulars. Those who enjoyed great prosperity, or met with any extraordinary good fortune, and such as were too much elated by praise and flattery, were more particularly liable to the effects of fascination. Hence when the Romans praised any thing or person, they used to add, *Præfiscini* or *Præfiscine dixerim*, to avert any fascination that might ensue, and to prove that their praise was sincere.

It is remarkable that the same superstition prevails to the present day in several parts of the world: even in the northern part of our island, and in Ireland. In Greece it is at present called *kako mati* (κακο ματι), and its effects are averted by spitting, in the same manner as was practised by the ancients against fascination (Theocr., 'Idyl.' vi. 39) and ill omens of every kind. In Italy it is called *malocchio*, and among the lower orders of people its effects are supposed to be very powerful and fatal. When praise is bestowed on beauty, riches, or any other advantages, the person praised immediately exclaims, "se malocchio non vi fosse," from an apprehension that the praise may not be sincere, but proceeds solely from a malicious intention to injure. This exclamation is accompanied with a sign of the hand, or by holding up pieces of coral, shells, or various kinds of stones worn as amulets.

The belief in fascination is extremely ancient, and in the opinion of some is connected with the story of Medusa and the Gorgons, whose eyes caused immediate destruction. From this source the superstition of the evil eye is probably derived.

Virgil alludes to this superstition in his third Eclogue:—

"Nescio quis teneros oculus mihi fascinat agnos."

Scot, in his 'Discovery of Witchcraft,' has one or two passages relating to it. He says, p. 35, "The Irishmen affirm that not only their children but their cattle are (as they call it) *eye-bitten* when they fall suddenly sick." It is likewise mentioned in Martin's 'Description of the Western Islands of Scotland,' in Heron's 'Journey,' vol. ii. p. 223, and in several volumes of the 'Statistical Account of Scotland,' as still believed there.

"Nothing," says Dallaway, in his 'Account of Constantinople,' 4to. Lond. 1797, "can exceed the superstition of the Turks respecting the Evil Eye of an enemy or infidel. Passages from the Koran are painted on the outside of the houses, globes of glass are suspended from the ceilings, and a part of the superfluous caparison of their horses is designed to attract attention, and divert a sinister influence."

Lane, in his 'Modern Egyptians' (1836), testifies to the general belief in the ill-effects of the evil eye still prevailing in Egypt, and details the superstitious precautions taken to guard against it.

EVIL, KING'S. [Scrofula.]

EVOLUTE. [Involute and Evolute.]

EVOLUTION. [Involution and Evolution.]

EVOLUTIONS. [Manœuvre.]

EVONYMINE. A crystalline, bitter, and neutral non-azotised substance, found in the *Evonymus europæus*.

EXAMINATION. [EVIDENCE.]

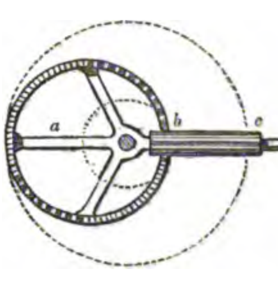
EXANTHEMATA (*Exanthematous diseases*), ἐξάνθημα, an *efflorescence;* a term under which are comprehended the eruptive fevers, or the diseases commonly termed rashes. Rashes are superficial red patches, variously figured, and diffused irregularly over the body, leaving interstices of a natural colour, and terminating in cuticular exfoliations. Fever is an essential element in the definition of an exanthematous disease, as this term is usually employed by nosologists; but the writers on cutaneous diseases give to it a modified signification, and comprehend under it only those diseases which are properly termed rashes, whether those rashes are attended with fever, and whether they are contagious or not. Thus Dr. Bateman comprehends under the order Exanthemata measles, scarlet fever, nettle-rash, roseola or the rose, purpura, and erythema.

EXARCH was the title of the governor of Italy under the Byzantine Emperors, established by Justinian after the reconquest of Italy from the Goths in the sixth century. The first exarch was Narses, who was also the greatest, about A.D. 568, and who held the exarchate for fifteen years. The residence of the exarch was at Ravenna, then a sea-port town, and the great entrepôt between Greece and Italy; and Italy was nearly equally divided between the kingdom of the Longobards and the exarchate of Ravenna, which included the Romagna, the Adriatic coast, Venice, and Naples; while the more inland portions were held by the Longobards. The exarchs, who were generally chosen among the officers and favourites of the Byzantine court, were of course removable at the pleasure of the Emperor, but several of them remained in their office to the end of their lives. Their administration was often marked by acts of oppression and treachery, the results of Byzantine corruption as well as of the peculiar difficulties of their situation. They were engaged in frequent hostilities against the Longobards who had invaded the greater part of Italy, and were also not unfrequently at variance with the popes, and their authority was often confined within the walls of Ravenna. At last, in the year 752, Ravenna being taken by Astulf or Astolphus, king of the Longobards, the exarchate, as well as all dominion of the Byzantines over North Italy, was at an end; but the Greek emperors still retained possession of parts of Apulia and Calabria, where Bari became the residence of the catapan or Byzantine governor. (See 'Chronological Series of the Exarchs,' in Petau, 'Rationarium Temporum.')

EXCENTRIC. [PTOLEMAIC SYSTEM.]

EXCENTRIC, or ECCENTRIC, in machinery, a kind of wheel, or revolving cam, in which the axis or centre of motion does not coincide with the geometrical centre, or in which the periphery is not circular. A general notice of such contrivances, and a representation of the kind of excentric employed for working the valves of a steam-engine, will be given under WHEELS.

Excentrics of various kinds form an important class of mechanical expedients for converting one kind of motion into another. They afford means for converting continuous circular motion, in various ways, into alternating or intermitting rectilinear motion, or into curvilinear, though not rotatory motion. They also furnish means for producing, from the uniform speed of one revolving shaft, rotatory motion of continually varying speed in shafts placed in connexion with it. As an illustration of such an application, Professor Willis, in his 'Principles of Mechanism,' refers to an excentric crown-wheel contrived by Huyghens to produce some of the complex movements of a planetarium. The subjoined diagram will illustrate the action of this apparatus, *a* representing the crown-wheel, which is mounted excentrically upon a shaft which revolves with a uniform speed, and *b c* a pinion driven by it, and made so long that it may be acted upon either by that portion of the periphery of the crown-wheel which is nearest to its axis, and which describes in its revolution a path indicated by the small dotted circle, coming in contact with the pinion at *b*, or by the opposite portion of the periphery, which describes the path indicated by the large dotted circle, and engages the pinion at *c*, where it is intersected by that circle. As the distance from the axis of the crown-wheel to the point *b* is little more than one-third of the distance from the axis to *c*, and as the velocity of the axis or shaft is uniform, it follows that the pinion will be driven nearly three times as fast when in contact with that part of the periphery of the crown-wheel which lies farthest from the axis as when in contact with the part which intersects it at *b*, while every intermediate portion of the periphery of the crown-wheel will impart a different, but intermediate velocity. Such a combination of wheels might be driven by the pinion, in which case, supposing the pinion to have a uniform velocity, that of the crown-wheel, or rather of its axis, will vary. Further variations might be introduced by making the periphery of the crown-wheel of other than a circular form.



Excentrics may be driven by bands or straps; but unless the bands be very highly elastic, it is necessary to apply a stretching pulley or roller, which may be pressed against the strap by the action of a weight, to maintain a uniform degree of tension.

EXCENTRIC WHEELS. [WHEELS.]

EXCENTRICITY, a term applied to the ratio which the distance between the centre and focus of an ellipse or hyperbola bears to the whole semiaxis. [ELLIPSE; HYPERBOLA.] With regard to this word, it should be noted that in the older writings on conic sections it was not the *ratio* of these two lines, but the former of them, namely, the distance between the centre and focus, which was called the eccentricity.

Let a be the semimajor axis of an ellipse or hyperbola, b the semiminor axis, and e the eccentricity; then

$$\text{in the ellipse } e^2 = 1 - \frac{b^2}{a^2}$$

$$\text{in the hyperbola } e^2 = 1 + \frac{b^2}{a^2}$$

EXCESS. For a peculiar mathematical use of this term, namely, the *spherical* excess, see SPHERICAL TRIANGLE.

EXCHANGE. The rules by which operations of exchange are conducted must be either the simple rule of three or the chain rule.

In the simple and direct operation nothing but the rule of three can be required. Thus, the exchange between London and Paris being 25 francs 55 centimes to the pound sterling, 6732 francs are converted into English money by finding the fourth term of the following:—

25·55 : 1 : : 6732 : the answer.

and 139*l.* 14*s.* 6*d.* can be converted into French money by

1 : 25·55 : : 139*l.* 14*s.* 6*d.* : the answer.

But in the case of the indirect operation of passing money from one country into another through a third, a double operation of the rule of three is requisite, which may be facilitated by the use of the chain rule. Suppose, for instance, that the exchange between London and Paris is 25·55 francs to the pound sterling, and that the exchange between Paris and Hamburg is 100 marks to 189 francs. Then, to find out the *arbitrated* value (as it is called) of 139*l.* 14*s.* 6*d.*, remitted to Hamburg through Paris, we have

100 marks	are worth	189 francs
25·55 francs	„	1 pound
139*l.* 14*s.* 6*d.*	„	How many marks?

It is however more common, first to establish an arbitrated *rate* of exchange, by putting 1*l.* in the place of 139*l.* 14*s.* 6*d.*, and then deducing the value of the latter sum. This is more convenient, because it establishes a rate once for all until the exchanges vary.

But the student must not content himself with the simple exposition above given. There are many little matters of business which cannot be explained here, but which may be found in such works as Tate's 'Commercial Arithmetic,' and the 'Counting-House Guide' of the same author.

EXCHANGE. The term exchange is commonly employed by merchants to designate—first, the operation of the written instrument, by which the debts of persons residing in different countries, or in different parts of the same country, are brought to a condition for final liquidations; and, second, the varying price of such negociable instruments in the market, which price is determined by the course of mercantile transactions, by means of which the obligations of debtors residing at a distance from their creditors, are discharged without the transmission of coined money.

The first division of the subject is discussed under the title BILL OF EXCHANGE; the following article will comprise the second, and will include an investigation of the principles on which exchange transactions are based.

International, or, as it is commonly called, foreign trade, arises out of the unequal or exclusive capacity of different countries to produce the various objects of desire. One country, for instance, has abundance of coal and iron; another enjoys a climate especially adapted to the culture of the vine; whilst a third possesses some peculiar advantages for the growth of wheat. If interchange were not restricted by legislative enactments, if trade were perfectly free, the first country would supply the other two with iron wares, taking from the second wines, and from the third wheat; whilst the two last would, in like manner, exchange their respective productions with each other.

Peculiarities of soil and climate, abundance and cheapness of land or of labour, the exclusive presence of certain animals, vegetables, or minerals, high excellence in particular arts and manufactures, all give rise to interchange between nation and nation. Every country has some peculiarity which gives it an advantage, with respect to that peculiarity, over all other countries: it is by means of interchange that such advantages are shared equally among all.

In the article BILL OF EXCHANGE, already referred to, we have explained how this mode of settling accounts, between parties in different countries, arose; and the various legal rights, of the parties to a bill of exchange, are also in that article, fully explained.

In investigating that part of the subject which belongs to the present article it is necessary to bear in mind that different countries make use of different coins—different in denomination, in weight, and consequently in value. Thus, the pound is the money of England, the franc that of France, the dollar that of America. These several coins contain very different quantities of the precious metals. The dollar, for instance, contains about five times as much silver as the franc, whilst the guilder contains only twice as much. The value of a currency depends on the quantity of pure metal, contained in the coin which forms its legal tender, alloy being left wholly out of the account.

In the language made use of by merchants, the existence of a *par of exchange* is usually assumed. The Par of exchange, here in England, is the expression of the relative worth of the coins of two countries, with each other, at our Mint standard price. ('Report of House of Commons Committee of Secrecy on Bank, &c.,' 1819, p. 206.) Between two countries making use of the same metal a par may exist; but between two countries, one of which makes use, as its legal tender, of gold, and the other of silver, an invariable par cannot exist.

The following is a statement of the contents, in pure silver, of the several coins forming the money of account, of the several countries specified:—

	Grains.
Franc of France	69·4
Mark of Hamburg	105·15
Florin of Amsterdam	146·8
Dollar of America	370·1

Hence the mark is worth, in Paris, 1·515 francs; in Amsterdam, 14 stivers 5 pfennings; and in New York, 28·2 cents.

Gold is now a legal tender in America, and the sovereign is by law worth 4·87 dollars, making the eagle of 10 dollars worth 2*l.* 1*s.* 0¾*d.*; the dollar (of gold), 4*s.* 1¼*d.*; and the 100*l.* sterling equal to 487 dollars; all of which are different expressions for the *par* between England and the United States—both being gold-using countries.

We have said that a par of exchange cannot exist, between two countries, making use of different metals, as the standard of their respective currencies; we shall now explain the reason. Gold is the standard in England. The silver coin of England possesses a conventional value, independent of the market value, and the latter may fluctuate without affecting the former. Foreign coins, the franc or the guilder for instance, possess no such conventional value. They are merely a commodity, liable to fluctuation, with the varying price of silver.

Some time ago it was found that, in a period of ten years, the price of silver in the London market varied from 4*s.* 10⅛*d.* to 5*s.* 1*d.* per ounce of 444 grains pure, the medium price being 4*s.* 11⅞*d.* to 5*s.* The extreme prices gave the following results:—

Price of Silver per oz.		Value of Franc.	Value of £1.
s.	*d.*	*d.*	f.
4	10⅛	9⅛	26·30
5	1	9·54	25·15

Thus making a fluctuation in the so-called par of exchange of rather more than 4⅛ per cent.

The assumption of a par of exchange, where no par can exist, is likely to lead, at times, to great inconvenience. Suppose, for instance, that the par between Paris and London be assumed at 25·58 f., which is about the medium. Suppose further that the exchange is quoted at 26·30 f.; what would be the inference? Why that exchange was 2·8 per cent. in favour of England, and (the cost of transmission being much less than the above difference) that consequently bullion was about to pour into London. But suppose that, at the same time, the market price of silver had declined, in London, to 4*s.* 10⅛*d.* per ounce, and gold, in Paris, had advanced in a like ratio, what would be the effect? Why the supposed premium, in favour of England, would vanish, and the par, for the time being, would be brought to coincide with the actual rate.

The mining countries are the only exceptions to the rule, that no country can have the exchange permanently favourable or unfavourable with the whole world. 'Senior's Lectures Lect. I. on Transmission of Precious Metals, p. 17.

Though there exists no invariable par of exchange it is extremely useful to the merchant to know the average value of the currency of every country with which he trades, in order to ascertain, what may be called the *approximate par*, which must be the pivot around which fluctuations will necessarily turn. This approximate par (a term which we make use of for the sake of conforming, as nearly as truth will permit, to the language familiar to merchants) should be grounded, on the average value of a currency, taken on a period sufficiently long to include fluctuations from highest to lowest. To the approximate par so taken will be the tendency of the rate of exchange to conform.

The approximate par of exchange will be liable to be affected by four pairs of circumstances, in addition to a rise and fall in the price of the precious metals. These are—

1. Changes made by the supreme authority in the quantity of the pure metal contained in the coin by way of increase or diminution.
2. Depreciation from the use of paper money, and restoration.
3. Clipping, and restoration.
4. Wear and tear, and restoration.

1. *Legal Changes in the Coinage.* Governments have not unfrequently found the diminution of the quantity of the metal, contained in the current coin, an easy way of getting rid of improvidently contracted debts. The English pound was once a troy pound of silver; it is now about four ounces. The French livre, once probably the same quantity, is now less than a *seventieth* part of a lb.

A government, having borrowed *so many pounds* of its subjects, would find it a very convenient thing, when the day of payment should come round, to call ten or fifteen shillings 'a pound;' and as it would have all the debtors in the kingdom on its side, popularity would be divided on the measure. But although creditors, at home, may be compelled to submit to this robbery, creditors abroad cannot. Their contract is to receive a given sum of the money of their own country, and the only effect, of any debasement, will be that the foreign debt will require more of the debased money to liquidate it; in other words, exchange will fall in the ratio of the debasement. Thus suppose the sovereign to be reduced in weight 10 per cent., exchange on the Parisian Bourse, if at 25·58f., would fall to 23f. 2c. If, on the other hand, the franc were reduced, exchange would rise.

We can illustrate this by two historical facts. Formerly the Spanish dollar contained as much silver as 4*s.* 6*d.* sterling, and consequently the average value of 100*l.* was 444 dollars 44 cents. The weight of the dollar however has been since reduced, and it now contains only as much silver as 4*s.* 2*d.* sterling, so that the average value of 100*l.* sterling is now 480 dollars; the difference being 8 per cent. The old language of quotation however has never been wholly abandoned by the American merchants. They still assume the old par, so that when exchange is quoted at 10 or 11 per cent. premium—a premium which, as we shall presently see, could not be maintained for an hour—it is in fact at 2 or 3 per cent. only (the remaining 8 per cent. being nominal); and when it is quoted at 6 or 7 per cent. premium, it is in fact at 1 or 2 discount. The other fact to which we allude is the adoption of a gold standard, in the United States, at a rate, compared with silver, to render the American currency practically debased.

Before the introduction of the Gold Bill the average value of 100*l.* sterling, as we have seen, was 480 dollars; by the new standard, the quantity of gold contained in 100*l.* is now coined into 487 dollars, being a difference of 1·45 or nearly 1½ per cent. Thus the par between England and America is now 487 d. = 100*l.*, or adhering to the old (erroneously assumed) par, a nominal premium of 9·45 per cent.

2. *Paper Money.*—One of the evils to which paper money is liable is depreciation from excess. The market price of money, like that of every thing else, varies in the inverse ratio of its quantity. If it be scarce it will be dear; in other words, all other things will be cheap. If, on the other hand, money be in excess, it will be cheap; in other words, much of it will be given in exchange for other things. To say that prices are advancing, is equivalent to saying that money is getting cheaper and cheaper. The effect of issuing paper money in excess is, then, to make money, both metallic and paper, cheap. Being cheap, it becomes desirable to export it; but paper money is not available for this purpose, and hence metallic money is alone exported. Bullion in the uncoined state would, under such circumstances, advance in price, but the sovereign would be still a sovereign; hence there would exist a motive to convert coined money into bullion, or to export it. Bullion however would not be exported, except when it was really cheaper here than in other countries.

During the Bank restriction the depreciation reached 27·9 per cent. Gold was then worth 5*l.* 8*s.* per ounce, and silver 6*s.* 11*d.*, estimated in paper money. But at these nominally high prices the proportion between gold and silver was precisely the present average proportion, namely, 1 to 15·52; or, gold at 3*l.* 17*s.* 10½*d.*, and silver at 4*s.* 11⅞*d.* The Parisian par was then 18·43f. per 1*l.* sterling (instead of 25·58f.) so that although *coin* might be sent away as a cheaper mode of conversion than melting, bullion would not necessarily be an article of export, unless when exchange was really, and not merely nominally, against us.

We have seen that the present average value of the dollar is 4*s.* 2*d.*; when silver was at 6*s.* 11*d.* the value would be 5*s* 9¼*d.* in the depreciated English money. Hence a debt in London of 100*l.* could be discharged with 346 dollars 18 cents, whereas now it would require 480 dollars. The dollars remained unchanged, but 100*l.* of 1813 was worth only 72*l.* 2*s.* in gold.

As the par of 4*s.* 6*d.* was then, as now, retained, the depreciation was met by a heavy nominal discount of $27\frac{9}{10}$ per cent. It is unnecessary to pursue these calculations to other countries; the same principles apply to all countries.

It is scarcely necessary to observe, that, in the process of restoration, the phenomena are reversed. A restoration of the English currency, for instance, would be similar, in its effects, to a depreciation of the currencies of all other countries.

3. *Clipping the Coin.* In some countries the practice of clipping the coin still continues, and it is likely to continue just so long as people

will take clipped coin. If people would take shillings clipped into polygons, they would be so clipped in less than twenty-four hours.

The effect of clipping, on the exchange, is precisely similar to the two cases we have already examined. If the silver coin of France were clipped, to the extent of one-tenth of its weight, exchange would be affected to that extent. Instead of requiring only 25·58f., to purchase 1*l.* sterling on the Parisian Bourse, it would require 28·14f. Restoration would be equivalent to clipping the coins of other countries.

Some of the continental states, in which clipped coin circulates, have adopted an expedient to keep up the character of their money of account. This expedient is to transact all their dealings, with other nations, in what they call *Banco*, which may be defined money *as it ought to be*, to distinguish it from the current or clipped money, which may be called *money as it is*. The merchants keep their bank accounts in *money as it ought to be*, paying in the clipped money, or *money as it is*. They are charged with the depreciation, which is known by the term *Agio*. This is purely an arrangement of convenience.

4. *Wear of Coin.*—The case of a worn coinage is precisely similar to that of a clipped coinage, except that the latter is sudden in its effects, the former gradual. Hence depreciation, from wear, is much more likely to deceive, than that which arises from clipping. Restoration, by means of a new issue, reverses all the effects.

We have now enumerated the principal circumstances affecting the value of a currency. Fluctuations in the rate of exchange, proceeding from an alteration of the value of the medium in which price is quoted, are purely *nominal;* and so they are usually designated. They are alterations, proceeding from the altered quantity of the article purchased, and are analogous to an alteration of the price of wheat, from an alteration in the capacity of the imperial quarter.

What is usually called the *real* exchange is the actual market-price, determined by the same law as the price of sugar, corn, or broad-cloth, namely, the existing proportion between supply and demand.

The demand for bills of exchange arises out of the necessity of paying for importations. The supply arises out of the practice of drawing for the amount of exportations. If the supply and demand be equal—if for every pound's worth of goods imported there be exactly a pound's worth of exported goods to be drawn for—there will be no real exchange; that is, the real exchange, however much the nominal exchange may alter, will be at par.

When, however, the importations are not precisely equal to the exportations, exchange can no longer remain at par. An excess of importation would cause exchange to advance against the importing country. Let us suppose a case. Let us suppose that an actual or anticipated advance in the price of wheat causes the transmission of extensive orders to the north of Europe. This would produce a sudden demand for bills of exchange—not perhaps to the extent of the orders, for in all probability goods adapted to the markets of the wheat-growing countries would be sent in part payment—but, at all events, to a considerable amount. There would accordingly be an advance in the rate of exchange, first on the wheat-shipping ports, and next on all other countries. Thus, England imports wheat from Danzig, and exchange on Danzig rises. But exchange on Amsterdam is at par, as it is also at Amsterdam on Danzig. Hence the wheat-importer would buy a bill on Amsterdam, and with the proceeds would there buy a bill on Danzig. But the buyer of exchange on Amsterdam cannot go into the market without causing an advance in the ate. In this way the advance becomes general.

The real exchange, however, is subject to a limit beyond which it cannot advance. A rise in the exchange will be limited by the aggregate amount of the following items: 1. The cost of obtaining the precious metals here. 2. The charges of transportation. 3. The profit of the lender for the use of his money: which two last expenses form the scale of the rise of the exchange abroad. (Report of Committee of Secrecy, &c., p. 181.)

But an advance in the rate of exchange, even up to this point, cannot long be maintained. The tendency in an advance in the rate is to check importation and stimulate exportation. Articles which would only just pay with exchange at par would pay a profit sufficient to nduce exportation where the exporter could secure 1 or 2 per cent. more for his draft. Thus, by the stimulus to exportation, the supply of bills would be increased to meet the demand, and *pro tanto* to check the advancing rate of exchange. On the other hand, an imported article which was only just paying when exchange was at par would cease to pay when it should cost the importer 2 per cent. more to make his remittance. Thus, whilst the cost of exporting the precious metals is the immediate check upon an advancing rate of exchange, the effect of the real exchange in stimulating or checking importation or exportation, as the case may be, is to work its own remedy. This natural and inherent tendency is assisted by the operations of the dealers in bills. Thus, the bills drawn on Great Britain in Italy almost always exceed in amount those drawn by Great Britain on Italy. One part of the business of a bill merchant is to buy up the excess of bills drawn in Italy on London, to sell them in any country on the continent that happens to be indebted to us, and this prevents the *real* exchange between Italy and this country from ever falling very low. The real exchange is, in fact, continually gravitating towards par, though at times superior forces may overcome that perpetual tendency.

Most of the errors which prevail in relation to the subject of exchange arise out of confounding the real with the nominal exchange. For the purposes of general reasoning, it is well to know what is the average value of the currencies of the several nations with which we have commercial relations; but for practical purposes the actual par for the moment should be rigidly calculated. Unless this be done, the practical merchant will be liable to continual error. For farther information on the subject, the reader may consult Mill's 'Elements of Political Economy,' chap. iii. sec. 16; Ricardo's 'Principles,' chap. vii., 'On Foreign Trade;' article 'Exchange' in the 'Encyclopædia Britannica;' and Tooke's 'High and Low Prices,' passim.

EXCHANGE, BILL OF. [BILL OF EXCHANGE.]

EXCHEQUER BILLS form the principal part of the unfunded public debt of this country. These bills are issued under the authority of parliament for sums varying from 100*l.* to 1000*l.*, and bear interest. They were first issued in the reign of William III.; and although their amount has since varied greatly at different times, the convenience which they afford to individuals and their advantage to the public have been such as to cause their constant issue. Their convenience to individuals arises from the circumstance of their passing from hand to hand without the necessity of making a formal transfer, of their bearing interest, and of their not being subject to such violent fluctuations as sometimes occur in the prices of the funded debt. This comparative steadiness in value is caused by the option periodically given to the holders to be paid their amount at par, or to exchange them for new bills to which the same advantage is extended; besides this, when a certain limited period has elapsed from the date of their first issue, they may be paid to the government at par in discharge of duties and taxes. The amount of premium that may have been paid at the time of purchase is consequently all that the holder of an exchequer bill risks in return for the interest which accrues during the time that it remains in his possession. The advantage to the public consists in the lower rate of interest which they carry compared with the permanent or funded debt of the nation, to which, however, they must in this respect bear some certain proportion. When the price of the public funds is high, the interest upon exchequer bills will be low; and if, through any public or commercial derangement, the funds should fall in price so as to afford a much more profitable investment than exchequer bills, the rate of interest upon these must be raised in order to prevent their payment into the exchequer in discharge of duties, a thing which would embarrass the financial operations of government. When first issued in the reign of William III., the interest borne by exchequer bills was *5d.* per 100*l.* per diem, being at the rate of *7l.* 12*s.* 1*d.* per cent. per annum. During the greater part of the war from 1793 to 1814, the rate of interest upon these securities was fixed at 3½*d.* per cent per diem, or *5l. 6s.* 5½*d.* per cent. per annum. Since the last-mentioned year the rate has been progressively reduced to 2½*d.*, 2*d.*, and 1½*d.* per 100*l.* per diem. In October, 1858, the rate was 1½*d.* per diem per 100*l.*, and in May exchequer bills were at a premium of 40 per cent.

The amount of exchequer bills 'outstanding and unprovided for' at the end of each of the last ten years was as follows:—

	£.		£.
1849 . .	17,758,700	1854 . .	22,783,000
1850 . .	17,756,600	1855 . .	26,596,600
1851 . .	17,742,800	1856 . .	28,050,700
1852 . .	17,742,500	1857 . .	25,627,300
1853 . .	16,024,100	1858 . .	25,883,700

EXCHEQUER CHAMBERS. [COURT; EXCHEQUER COURT.]

EXCHEQUER, THE COURT OF, is a superior court of record established by William the Conqueror, and reduced to its present order by Edward I.

It is the lowest in rank of the four great courts which sit at Westminster Hall, although in ancient times one of the first in importance, as all causes relating to the rights of the crown were there heard and determined, and the revenues of the crown were supposed to be received there.

Etymologists have exhausted much research in ascertaining the origin of the name: some assert that it is derived from the old French word *Eschequier*, a kind of abacus or table; or the German, *Schatz*, 'treasure.' The Latinised form of the word is *Scaccarium*. Camden says it was so called from the covering of the table at which the barons sat being party-coloured or *chequered*, and on which, when certain of the king's accounts were made up, the sums were marked and scored with counters.

The judges of the court of exchequer are the chancellor of the exchequer for the time being, the chief baron, and four other barons, who are created by letters patent, and are so called from their having been originally chosen from such as were barons of the kingdom, the court having been at first formed out of the *Aula Regis*. (Selden's 'Titles of Honour.')

The court of exchequer was formerly held in the royal palace. Its treasury was the great deposit of records from the other courts: writs of summons to assemble the parliaments were issued by its officers; and its acts and decrees, as they related almost entirely to matters connected with the revenue, were not controlled by any other of the ordinary courts of justice.

It now consists of two divisions, one of which exercises jurisdiction in all cases relating to the customs and excise, and other revenue matters generally. The other division, or Exchequer *of Pleas*, is a court of common law, in which all personal actions may be brought and prosecuted. This plea side of the court formerly comprised a court of equity; but by 5 Vict. c. 5, the jurisdiction of the court in equity was transferred to the Court of Chancery.

A plaintiff, when bringing an action in this court, previously to the Act for Uniformity of Process in personal actions (2 Will. IV. c. 39), fictitiously alleged himself to be the king's debtor, in order to give the court jurisdiction in the cause. He added that the defendant owed him money *quo minus sufficiens existit*, to pay the king's debt,—a state of things which the court, out of zeal for the revenue, immediately proceeded to remedy. It is not necessary now to resort to this fiction in order to bring an action in the exchequer; the proceedings of which in personal actions are precisely the same as those of the other superior courts. The procedure in suits, or more properly information, in the crown side of the court have been, by the statutes 22 & 23 Vict. c. 19, closely assimilated to proceedings in an ordinary action.

An appeal lies from this court to the justices of the courts of Queen's Bench and Common Pleas sitting in the exchequer chamber; and from their decision a further appeal to the House of Lords. [Courts.]

The Court of Exchequer in Scotland was established by the 6 Ann. c. 26. Its judicial powers and duties, after being subjected to various modifications, have been transferred to the Court of Session (2 & 3 Vict. c. 36.

The Court of Exchequer in Ireland was established by the 40 Geo. III. c. 39. Its jurisdiction resembles that of England.

EXCISE DUTIES, the name given to taxes or duties levied upon articles of consumption which are produced within the kingdom. This description, which has usually been given of excise duties, is more strictly applicable now than it was formerly, when the commissioners of excise revenue were also charged with the collection of duties upon various articles imported from foreign countries. Among these foreign articles were wine, spirits, tobacco, glass, and tea. The last named of these was the last that was withdrawn from the management of the Excise and transferred to the Board of Customs. There are still, it is true, certain duties to which the name of excise is applied, which can hardly be called duties upon consumption, although they are accessary to it, such as the duty on sales by auction and the sums charged for licences to permit parties to carry on certain trades.

Excise duties are said to have had their origin in this country in the reign of Charles I., when a tax was laid upon beer, cider, and perry, of home production. The act by which these duties were authorised was passed by the Long Parliament in 1643. This act contains also a list of foreign articles, and among others tobacco, wine, raisins, currants, and loaf sugar, upon which excise duties were imposed, in addition to duties of customs already chargeable. This act was adopted and enforced under the protectorate of Oliver Cromwell; and by the statute 12 Charles II. c. 24, the duties of excise were granted as a part of the revenue of the crown.

For a long time this class of duties was viewed with particular dislike by the people, on account of its inquisitorial interference with various industrial pursuits, and it certainly forms a very strong ground of objection against excise duties, that the security of the revenue which they yield is held to be incompatible with the perfect freedom of the manufacturer as to the processes which he may apply in his works. In every highly-taxed country where consumption-duties form part of the public revenue, it would seem, however, to be hardly possible to avoid the adoption of this class of duties. If, taking for our example an instance which is now exercising an injurious effect in a neighbouring country, it is found expedient to impose a customs' duty upon the consumption of foreign-made sugar, it is clearly necessary, for the protection of the revenue, that an excise duty should be imposed upon sugar of domestic production, otherwise the community at large is made to bear the load twice, once in the form of some other tax, and again to the producer of indigenous sugar, who will charge the consumer nearly as much as he would pay to the importer of foreign sugar, including the amount of the duty. By such means a branch of industry would be fostered, unprofitable to the country at large, and profitable only to the few persons by whom the indigenous sugar is produced, but whose profits will not long continue greater than the usual profits upon the employment of stock obtainable in the same country from other branches of industry. An attempt was made, some years ago, to set up a beet-root sugar manufactory in England, but parliament having imposed an excise duty upon the produce equal to the customs' duty charged upon colonial sugar, the attempt was not successful, which indeed is little to be regretted, for the reason already assigned.

Excise duties are liable to this among other very serious objections, that the regulations under which they are collected are made, perhaps unavoidably, to interfere with processes of manufacture, so as to prevent the adoption of improvements which would be beneficial first to the manufacturer and afterwards to the community at large, which must always be interested in their adoption, because of the greater excellence of cheapness of the products which it is the object of the experimenter to attain. It will give some idea of the extent to which this interference is injurious, if we state, on the authority of a gentleman conversant with all the details of the art of calico-printing, that upon the same premises, with the same capital, and employing the same amount of labour, double the quantity of cloths are now printed which could have been printed previous to the repeal of the duty, and to the consequent withdrawal of the excise officers from the works. Another great objection that may be urged against excise duties is, the facilities which they offer for the commission of frauds against the revenue, an offence which, in the eyes of many persons, is of a venial kind, but which too often ultimately demoralises those by whom it is committed.

In 1845, Sir Robert Peel commenced a reform in the excise laws by repealing those on glass and sugar, and substituting a licence for auctioneers instead of the excise duty on the sale. The duty on bricks and soap was also subsequently removed. In 1849, the Board of Excise was incorporated with that of Stamps and Taxes, under the name of the Board of Inland Revenue. The gross amount of the excise duties in 1844, before the remissions began, was 14,469,366*l.*; in 1858 they amounted to 17,884,300*l.* 16*s.* 3*d.*, from the following sources:—

	£	*s.*	*d.*
Spirits	8,950,195	8	3
Malt	5,412,777	1	8
Licences	1,436,238	17	7
Paper	1,142,113	10	1
Hops	378,320	4	0
Railways	339,568	16	3
Stage carriages	124,993	14	11
Hackney carriages	82,093	14	6
Game certificates	12,228	6	0
Racehorses	5,771	3	0
	£17,884,300	16	3

The excise duties are now confined to hops, malt, paper, spirits, and (beet-root) sugar, of which last none has been brought to charge since 1856. In 1858, of hops there were charged 53,125,101 lbs., of which 4,177,251 lbs. were exported; of malt there were charged 41,605,665 bushels, and 5,049,321 bushels were made free of duty for the use of distillers, and 1,549,213 bushels were exported; of paper there were charged 192,847,825 lbs., of which 16,548,828 lbs. were exported; of spirits there were charged 23,686,751 gallons, 1,096,409 gallons were made free of duty for exportation, and 1,570,548 gallons of that charged were exported. In 1857, 5,190,538 gallons had been exported. On all the quantities exported, which had been subjected to duty, a drawback is allowed, and the malt exported includes the estimated quantity used in beer exported.

The trades in which licences are necessary in order to carry them on, are shown in the following list, with the number of persons in each trade to whom licences had been granted in the year ending March 31, 1858, and the gross amount of tax paid. In some of the trades, as brewers, maltsters, &c., a different amount is paid for the licence, according to the extent of the trade.

		£
Auctioneers	4,358	43,580
Brewers	40,794	81,030
Beer and cider sellers . . .	127,352	304,688
Maltsters and dealers in malt . .	7,011	19,291
Paper-makers	397	1,642
Soap-makers	369	1,505
Distillers	189	1,963
Rectifiers	157	1,588
Makers of stills	42	22
Chemists using stills . . .	219	110
Spirit-dealers	93,936	560,557
Retailers of sweets	9,896	10,412
Tea-dealers	151,975	84,663
Tobacco manufacturers and dealers	252,048	70,888
Vinegar-makers	69	345
Wine-dealers	34,551	88,765
Retailers of liquors or tobacco on board vessels	365	383
Postmasters	29,247	137,497
Stage-carriage proprietors . .	7,630	10,695
Hackney-carriage proprietors (London)	5,474	5,474
	766,079	£1,425,098

EXCITANTS. [Stimulants.]

EXCITATION, ELECTRIC. [Electricity, Common.]

EXCOMMUNICATION, from *Excommunicatio*, is the highest ecclesiastical censure which can be pronounced by a spiritual judge. This punishment, according to some opinions, had its origin in the advice given by St. Paul when reproving the early Christians for scandalising their profession by prosecuting law-suits before heathen judges; and the apostle accordingly recommended them to leave all matters in dispute between them to the decision of the Ecclesia, or congregation of the faithful. This advice was soon followed, and heathen tribunals were seldom afterwards occupied by the controversies of the Christians.

The bishop and his clergy soon became the judges: the bishop ultimately became sole judge in these disputes. Possessing no coercive powers to enforce his decree, the Courts Christian, as they came to be called, were obliged to adopt the only means of which they could avail themselves to bring the refractory to submission, namely, by excluding them from the rites of the Church, and warning other Christians from their company. A Christian thus shut out from the fellowship of his brethren could not do otherwise than submit.

This censure, although instituted by the primitive church as the means of preserving its purity, and of enforcing obedience to its just laws, was afterwards used for the promotion of ecclesiastical power, and was converted into an engine of the greatest oppression in those countries which were most subject to ecclesiastical rule. (Robertson's 'History of Charles V.,' vol. ii.)

In England excommunication became at a very early period the instrument of punishment of the bishops, and others possessing ecclesiastical jurisdiction. It was divided into the greater and the less excommunication. The latter only removed the person from a participation in the sacraments; the other was called anathema, and not only removed the party from the sacraments, but from the Church and all communication with the faithful, and even deprived him of Christian burial. Subjects were absolved from their allegiance to an excommunicated prince: indeed, they were forbidden to obey him. Gregory V. was the first prelate who ventured to excommunicate a reigning prince, in the case of Robert, king of France, in 998. John and Henry VIII. are well-known instances in English history. The latest instance of all was Napoleon I., in 1809, by Pius VII.

The greater excommunication was hurled against diviners, heretics, their receivers and comforters; simoniacs; violators and plunderers of churches; those who spoiled clerks going to Rome; the plunderers of the property of a bishop which ought to go to his successor; those who gave aid, favour, or counsel to excommunicated persons; and those who laid violent hands on clerks or religious persons, or commanded others to do so. Those punished with the less excommunication were persons committing any mortal sin, as sacrilegious persons; those who received a church from lay hands; notorious offenders; those who talked with, saluted, or sat at the same table with, or gave anything in charity to persons excommunicated by the greater excommunication, unless they were familiars or domestics.

Excommunication was also pronounced for other matters which belong to ecclesiastical jurisdiction, as adultery, incontinence, fornication, &c., or for contempt of any ecclesiastical order or sentence. The sentence was preceded by three monitions at due intervals, or one peremptory, containing the legal space of time, with a proper regard to the quality of the person and the nature of the offence. But, as Blackstone remarks, "heavy as the penalty of excommunication is, considered in a serious light, there are, notwithstanding, many obstinate or profligate men, who would despise the *brutum fulmen* of mere ecclesiastical censures, especially when pronounced by a petty surrogate in the country, for railing or contumelious words, for non-payment of fees or costs or other trivial causes. The common law, therefore, compassionately steps in to the aid of the ecclesiastical jurisdiction, and kindly lends a supporting hand to an otherwise tottering authority." This was effected by the writ "de excommunicato capiendo;" but before it could be granted the contumacy and contempt of the party were to be certified by the bishop to the Court of Chancery by letters under his seal; and by 5 Eliz. c. 23, the writ was made returnable into the King's Bench. The cause of excommunication was also to be stated in the writ, in order that the court might judge as to the justice of the case. The sentence of excommunication might be revoked by the judge who passed the sentence, or upon appeal the party might be absolved. Absolution generally belonged to the same person who passed the sentence, unless in some particular cases, which were referred to the pope or a bishop. (Reeves' 'Hist. of English Law;' Sullivan's 'Lectures.')

By a sentence of excommunication, both greater and less, those denounced were excluded from the right of Christian burial, from bringing or maintaining actions, from becoming attornies or jurymen, and were rendered incapable of becoming witnesses in any cause. But since the 53rd Geo. III. c. 127, excommunication cannot now be pronounced in England, except in certain cases (as spiritual censures for offences of ecclesiastical cognizance); and by that statute, "no person who shall be pronounced or declared excommunicate shall incur any civil penalty or incapacity, in consequence of such excommunication, save such imprisonment, not exceeding six months, as the court pronouncing or declaring such person excommunicate shall direct." The proceedings in those cases, in which excommunication may still be pronounced, are the same, as to the issuing and return of the writ, as they were before the Act of 53 George III. By the same Act, when any person shall refuse to appear when cited by an ecclesiastical court, or shall refuse to obey the lawful order or decree of such court, no sentence of excommunication (except in the cases above alluded to) shall be pronounced; but a writ "de contumace capiendo" shall issue, which in effect is the same as the old writ "de excommunicato capiendo" was. The various difficulties which formerly existed in courts of law with respect to excommunication are thus obviated.

(Blackst., *Comm.*, Mr. Kerr's ed., vol. iii., p. 107.)

EXCRETIN, a substance discovered by Dr. Marcet in the excretions from the human bowels.

EXCRETION. [Secretion.]

EXCRETOLIC ACID. An olive-coloured fatty acid, found in human excrement. Its composition is not known.

EXECUTION is the effect given to the judgment and other proceedings analogous to judgments of courts of law and in civil suits. This term denotes the process by which a party is put into the actual possession of that to which by the proceedings of a court he appears to be legally entitled.

As a judgment of a court of common law ascertains that the party is entitled to the possession of some subject of a real or personal nature; or to recover damages in respect of property withheld or injuries done, so the execution founded upon such judgment will be framed with a view to putting the party in whose favour the judgment is given either in the actual possession of the thing in dispute, or to enable him to obtain pecuniary compensation.

For this purpose a written command issues in the name of the king or other lord or owner of the court, to an officer of the court: when the judgment is in one of the king's superior courts at Westminster, the officer of the court for this purpose is the sheriff of the county in which the property is situate, or, in the case of pecuniary compensation, the sheriff of the county in which the party from whom such compensation is due is supposed to be.

Where lands or other corporeal hereditaments are recovered, the process of execution is called habere facies possessionem. [Habere Facias Possessionem.]

A judgment in the action of detinue [Detinue] establishes the right of the recoveror to the possession of a specific personal chattel, and the writ of execution called a distringas issues, requiring the sheriff to coerce the defendant by his distringas (distress) to restore the specific chattel, or at the option of the plaintiff that he cause to be made of the defendants' goods the assessed value of such chattel. The plaintiff is in either case entitled to recover his damages, costs, and interest in the action.

A judgment for the defendant in replevin [Replevin] establishes his right to the possession of the personal chattel which formed the subject of the litigation. In the ordinary case of an action of replevin after a distress, the right of the defendant in respect of the chattel distrained is merely to hold it as a security for the payment of the debt or duty, the payment or performance of which is sought to be enforced by the coercion of a distress. [Distress.] The writ of execution requires the sheriff to cause the chattel to be restored to the possession of the defendant. This is called a writ de retorno habendo, and in case the sheriff is unable to find the chattel, further process issues commanding him to take other chattels of the plaintiff as a substitute for that which is withheld, by a writ called a capias in withernam.

The most ordinary cases of execution are those in which pecuniary compensation is to be obtained, but in these cases the sheriff is not authorised directly to take money from the party by whom it is to be paid. Formerly the only mode of obtaining this compensation was by process of distringas or distress. But execution of judgments or other records establishing pecuniary claims may now be had by a writ of fieri facias [Fieri Facias] affecting the personal property; by writ of elegit [Elegit], affecting both real and personal property; and by capias ad satisfaciendum [Capias], by which compliance with the pecuniary demand is enforced by detention of the person of the defaulter in prison until the claim be satisfied, or the adverse party consents to his discharge, or until he be discharged by process of law under the Bankrupt or Insolvent Acts.

A subject is not entitled to pursue all these remedies at once; but in the case of the crown, the right to obtain satisfaction from the goods, lands, and person of its debtor may be enforced simultaneously, by writ of capias, and extendi facias, or extent. [Extent.]

Execution is the term applied to denote the giving effect to the sentence of a court of justice. In this sense it is most commonly used with reference to the execution of sentence of death. [Sheriff.]

EXECUTOR. An executor is he to whom another man commits by will the execution of that his last will and testament. He answers in some degree to the *hæres designatus*, or *testamentarius*, in the civil law, as to the debts, goods, and chattels of his testator; but the origin of executors seems to be properly traceable to a constitution of Manuel Comnenus (περὶ διοικητῶν τῶν διαθηκῶν). All persons who are capable of making a will, and some others besides, as married women and infants, are capable of being made executors; but infants are by statute rendered incapable of acting in the execution of the will until they attain the age of twenty-one.

An executor can derive his office from a testamentary appointment alone, though it is not necessary that he should be appointed by express terms; any words of the testator indicating an intention to make the appointment are sufficient: in this case he is usually called "executor according to the tenor." If no executor is appointed by the will, administration is granted out of the Court of Probate, with the will annexed, in which case the administrator is bound to obey the directions given by the will. An executor may renounce probate; but having once acted, he cannot divest himself of the office or its liabilities; nor can an administrator who has accepted the office, get rid of his responsibility.

An executor may do many acts in execution of the will, even before probate, as paying and receiving debts, &c., but he cannot, before probate, sustain actions or suits. An administrator can do nothing till the letters of administration are issued; for the former derives his power from the will, and not from the probate: the latter owes his entirely to the appointment of the court. If an executor die before probate, administration must be taken out to his testator, with the will annexed; but if an executor, having proved the will, die, his executor will be the executor and representative of the first testator, unless, before proving the will of the second testator, he expressly renounces the execution of the will of the first. If the executor dies intestate, his administrator is not the representative of the testator, but an administrator *de bonis non* of the testator must be appointed by the court. If there are several executors, the office survives, and is transmitted ultimately to the executor of the surviving executor, unless he dies without having appointed an executor. Executors have a joint and entire interest in the effects of their testator; any one of them is capable of acting by himself; and the receipt of a debt, or the transfer of property by one, is as valid as if it had been done by all.

If a stranger takes upon himself to act as executor without any authority, as by intermeddling with the goods of the deceased, he is called an executor *de son tort* (of his own wrong), and is liable to all the trouble of an executor without any of the advantages attached to the office. He is chargeable with the debts of the deceased, so far as assets come to his hands; and is liable not only to an action by the rightful executor or administrator, but also to be sued as executor of the deceased by his creditors and legatees. The only advantage which an executor derives from his office is the right to retain any debt due to him from the testator, as against creditors of equal degree, and this privilege is allowed him, because he cannot take any legal steps to recover payment. This, though practically a privilege, is in reality only a provision of the law that he shall not be prejudiced by his appointment; otherwise as a man cannot sue himself, all the other creditors would, by instituting a suit against the executor, gain priority over him in respect of their debts.

The duties of executors and administrators are in general the same, the only essential difference between them being, as before mentioned, the mode of their appointment. Their duties are to bury the deceased, to prove his will in the proper court, to collect and get in his goods and chattels, to pay his debts in the order appointed by law, and also his legacies, if he has bequeathed any, and to dispose of the residue of his goods and chattels in the manner by the will directed, or according to the statutes for the distribution of the effects of intestates, if there should be a total or partial intestacy. Executors and administrators are liable to an action at law, and also to a suit in equity, for the payment of the debts and liabilities of their testator or intestate; and to be sued for the legacies bequeathed by him, and the due administration of his estate: but no action at law lies for a legacy, at least not until after the executor has assented to it, as it is called, that is, has acknowledged the sufficiency of the assets after providing for the payment of the debts. [Legacy.]

It appears to have been a subject of much controversy whether the probate of wills was originally a matter of exclusive ecclesiastical jurisdiction, but whatever may have been the case in earlier times, it is certain that until the passing of the 20 & 21 Vict. c. 77, the Ecclesiastical Courts were the only courts in which, except by special prescription, the validity of wills of personalty could be established or disputed. By that act the ancient jurisdiction of those courts, in matters of probate and administration, was transferred to a new court thereby established and styled "The Court of Probate." A will should be proved within six months after the death of the testator, or within two months after the termination of any dispute respecting the probate. (See 55 Geo. III. c. 184, sec. 57.)

Executors and administrators are treated by the courts of equity as trustees for the creditors, legatees, and next of kin of their testators or intestates. They are bound to administer the assets according to their due order of priority, and to pay the debts of the deceased in like manner. The probate is exclusive evidence of a will of personalty; but courts of equity assume the jurisdiction of construing the will in order to enforce the performance of the trusts by the executor: hence they are sometimes styled courts of construction, in contradistinction to the Court of Probate. Formerly, the personal estates only of persons deceased were liable for the payment of their simple contract debts; but now, since the statute 3 & 4 Will. IV. c. 104, real estates are liable for the payment of debts of that nature; and it may be broadly stated that all the real and personal estates of the deceased are assets for the payment of his debts. The personal estate is liable in the first instance, unless the testator direct otherwise. Estates descended are applied before estates devised; and in other respects the estates of the deceased are administered in the order laid down by the courts.

The debts are also payable in a certain prescribed order. 1. The funeral expenses, the expenses of probate, and the costs of a suit for the administration of the estates, if any be instituted. 2. Debts due to the crown on record or specialty. 3. Certain debts, which by statute are to be preferred to others, as poor-rates, by stat. 17 Geo. II. c. 38, &c. 4. Debts of record, as judgments, statutes, and recognisances. 5. Specialty debts, that is, debts due on bonds or instruments under seal. 6. Simple contract debts, as upon bills of exchange and ordinary verbal engagements. It seems that in this class debts due to the crown and the wages of domestic servants are entitled to priority.

The executor must pay the debts in the order mentioned; for if he apply the assets in payment of those of a lower degree, he will be personally answerable, to the extent of the assets misapplied, to the creditor of the higher degree. He may, however, pay a debt of an inferior degree before one of a superior, provided he has no notice of the latter, and a reasonable time has elapsed after the testator's death; except in the case of debts of record, of which the executor is bound to take notice. An executor or administrator may also retain his own debt as against creditors of an equal degree; and he may pay any one or more debts to creditors of equal degree, although thereby he may exhaust the assets, unless a suit or action be commenced against him; and even in that case he may, by confessing a judgment, enable a creditor to obtain priority. But notwithstanding an action or suit be commenced, he may pay a creditor of a higher degree than the one proceeding against him; save only where the suit is for a general administration of the estate, when the executor should not make any farther payments.

The debts being all paid, the next duty of an executor or administrator is to pay the legacies, and distribute the personal estate to the next of kin of the testator if there be any overplus; but where the testator has made a residuary legatee, he is entitled to the surplus. If the assets are not sufficient for the payment of the legacies, the executor must pay to each legatee an equal proportion of his legacy, unless the testator has directed the order of payment, in which case the legacies must be paid in full in the prescribed order, and the whole loss must fall upon the last in order. Specific legatees, that is, persons to whom a specific fund or article of property is given by the will, are not liable to abatement of their legacies, but receive the fund or article whether the assets are or are not sufficient to pay the other legatees; though if the fund is changed, or the article sold, or from any other cause is not in existence at the death of the testator, the legacy fails, or in technical language is said to be adeemed. Executors and administrators cannot be compelled to pay legacies or distribute the personal estate before the expiration of a year after the decease of the testator; and not even then, if notice has been acquired or there is reasonable ground to suspect the existence of debts and liabilities. Indeed, unless the assets are of ample amount, the executor or administrator should not pay within the year, even though the testator has directed it to be done; for it has been held that such a payment affords no defence against a creditor, and the testator or intestate may be bound by covenants upon which subsequent liabilities may accrue; or he may have been a trustee, and some maladministration of the trust estate may be discovered after the lapse of many years. In these and many other cases, executors and administrators should not part with the assets until all chance of liability is at an end, or security be given by the parties receiving them to refund in case of need. This last course will sometimes be directed by a court of equity in a suit for a legacy; for though an executor or administrator may recover from the legatees or next of kin to whom he has handed over the assets in case of subsequently-discovered debts of the deceased, it is obvious that this is a very insufficient and uncertain security. Where a legatee is an infant, or the testator has directed his executors to invest any portion of his estate in the funds, or has provided for some future payment to be made, or from any other cause, an investment by the executors becomes necessary, they are, in the absence of any express direction to the contrary, bound to make such investment in the Three per Cent Consols, that fund being considered by the Court of Chancery as the most desirable for the purpose of investment. The rule is inflexible, and an executor who should disregard it would run great risk of having to pay the costs of a suit to compel him to place the money in that fund, and to make good any loss which might occur through the change of securities.

Full information upon these subjects will be found in the valuable work of Mr. Justice Williams, on the law relating to Executors and Administrators; and in Jarman on Wills, and Powell on Devises.

EXE'DRA (ἐξέδρα), a name given to certain open chambers or recesses in the buildings of the ancients. There were numerous exedræ in the baths. Vitruvius says the spacious exedræ of the Greek palæstra were furnished with seats. The exedræ were placed in the three porticos of the palæstra. (Vitruvius, v. c. 9.) Sometimes in houses a covered hall, and of a square form, was called exedra. (Vitruvius, vi. cap. 5.) In the disposition of the Greek house the exedræ were placed looking to the west. (Vitruv., vi. cap. 10.)

EXEMPLIFICATION. [Record.]

EXERCISE. [Analeptics.]

EXETER or EXON DOMESDAY, the name given to a record preserved among the muniments and charters belonging to the dean and chapter of Exeter Cathedral, containing a description of the western parts of the kingdom, comprising the counties of Wilts, Dorset, Somerset, Devon, and Cornwall; supposed, as far as it extends, to contain an exact transcript of the original rolls or returns made by the Conqueror's commissioners at the time of forming the General Survey, from which the Great Domesday itself was compiled. It is written on vellum, in the form of a book of the small folio size, containing 532 double pages. The skins or sheets of vellum of which it is composed vary in the number of leaves which they comprise from one to twenty; the lands of each of the more considerable tenants beginning a new sheet, and those of almost every tenant a new page. The lands in the counties of Devon, Somerset, and Cornwall belonging to one tenant are classed together, the counties following each other, though not always in the same order; and, in like manner, the summaries of property in Wilts and Dorset are classed together.

The manuscript begins with the "Inquisitio Geldi," or taxation of the hundreds of Wiltshire, of which it contains no less than three copies, the third seeming to be a corrected edition of the other two. The taxation of the hundreds of Dorsetshire follows, and after it those of Devonshire, Cornwall, and Somersetshire. The Inquisition for each hundred states—1, the total number of hides; 2, the number held by the king and his barons in demesne, with an enumeration of those for which the tax was not paid; 3, the number of hides for which the tax was paid, and its amount; 4, the tax in arrear, and the reasons for its so remaining. Throughout, the geld or tax is computed at the rate of 6*s.* for every hide.

Upon collating the returns of lands which form the great body of the Exeter Survey with the Exchequer Domesday, they have been found, with a few trifling variations, to coincide; one entry of property alone being discoverable in the Exeter which is omitted in the Exchequer Domesday, relating to Sotrebroc in Devonshire. The Exeter manuscript, however, is not complete in its contents. There are considerable omissions of lands in Wiltshire, Dorsetshire, and Devonshire; but these have evidently been cut out and lost. In Cornwall every manor mentioned in the Exchequer occurs in the Exeter Domesday. One leaf of this record was accidentally discovered in private possession within these few years, and has been restored to the manuscript. In the spelling of the names of places and persons there is a remarkable difference between the two records. The names of tenants in King Edward's time are far more numerously preserved in the Exon than in the Exchequer Domesday. In the systematic arrangement of the subject matter, the Exchequer Domesday bears unquestionably a decided preference over the Exon Domesday. Occasional insertions in the margin of the Exon Survey are entered in the text in that of the Exchequer. The lands of the great barons, also, in the Exon Survey are in a few instances intermixed. In folio 161 of the Exon, although the title of the lands described is "Terra Abbatis Glastingheberiensis in Devenescira," yet in fact there is only one of the manors in that county; the rest are all in Somersetshire, and are entered as such in the Great Domesday. On the contrary, in folio 194 of Exon, the "Terræ Ecclesiarum quæ datæ sunt Sanctis in elemosina," from all that appears on the face of the record are in Somersetshire, whereas they are really in Devonshire, and are so placed in the Exchequer Domesday.

The most striking feature, however, of the Exeter Domesday, in which it uniformly supplies us with additional knowledge to that in the Exchequer Survey, is the enumeration of live stock upon every estate; there is an account of the number of oxen, sheep, goats, horses, and pigs, exactly in the same manner as it is given in the second volume of the Great Domesday. The reason for omitting this enumeration in the breviated entries of the first volume of the Great Survey is self-evident. The live stock was altering every day and year; the enumeration of it, therefore, could be of no further use than for the exact time when the survey was made. A comparison of this part of the Exeter with the second volume of the Great Survey tends greatly to corroborate the notion that the returns of the counties of Essex, Norfolk, and Suffolk, were transcribed in full from the original rotuli, in the same manner as the Exeter Domesday. The difference between the two surveys as to diction, when they agree in sense, is likewise remarkable.

The utility of this record for the purpose of comparison with the Exchequer Domesday is obvious. The Exeter Domesday was published with several other surveys nearly contemporary, by order of the Commissioners upon the Public Records, under the direction of Sir Henry Ellis, in a volume supplementary to the Great Domesday, folio, London, 1816.

EXHAUSTING SYRINGE. [AIR-PUMP.]

EXHAUSTIONS, METHOD OF. [GEOMETRY OF THE GREEKS.]

EXHIBIT. A deed or writing proved by a witness or admitted by the parties to a suit in court. The documents attached to affidavits, as referred to in or verified by them, are also termed exhibits.

EXHIBITIONS, INTERNATIONAL. The international exhibitions of the last few years, in London, Dublin, New York, and Paris, following the national exhibitions held in these or other places, have had an important influence on the advancement of manufacturing art, and in the application of tasteful design to articles in every-day use. How far this influence has extended may be a disputed point; but no thinking person can regard it as otherwise than beneficial, so far as it goes. It may be well therefore to give brief notices of the principal of these exhibitions, beginning with that at Hyde Park in 1851.

Great Exhibition of 1851. This was the first international display of manufactures; the first exhibition of the industry of all nations.

The proposition for a great exhibition of national manufactures to be held at intervals of three or more years seems to have originated in 1845 with the Society of Arts, of which Prince Albert was president. On its first announcement the project was coldly received, and some three years were suffered to elapse before it was again brought distinctly before the public. Meantime the annual exhibitions of the society were rendered more attractive, and manufacturers and commercial men began to feel increased interest in the proposal. By the beginning of 1849 the council of the society had matured a plan, of which, in March of that year, they published an outline. The society now petitioned parliament for pecuniary aid. Prince Albert, who had all along warmly supported the proposal, conceived that the time had arrived for imparting to it a much more magnificent form, by throwing the exhibition open to the industry of the world. The council adopted his suggestion, and measures were taken for enlisting in behalf of the scheme the sympathies of manufacturers. The idea of an international exhibition of industry at once seized the general mind. At the preliminary meeting held in the city under the presidency of the Lord Mayor for the purpose of publicly enunciating the scheme, it was received with the utmost favour, and the provinces speedily gave in their cordial adhesion. Upon the suggestion of Prince Albert, application was made to the government for the appointment of a royal commission for managing an exhibition of the works of industry of all nations; and a royal warrant was accordingly issued in January, 1850, appointing such a commission, with Prince Albert as its president. At the first meeting of the commission, a provisional contract which had been entered into with Messrs. Munday, for erecting a building, was annulled on terms mutually arranged; and plans on a much larger scale were laid. The commissioners now appointed (January 24) a building committee, to whom was entrusted the entire arrangements for providing a suitable edifice. On the 25th of January a great meeting was held at the Mansion House, at which the hearty adhesion of various influential merchants and manufacturers was announced, and a general subscription was inaugurated with a view to raising funds for meeting every kind of outlay connected with the undertaking. It was followed by corresponding meetings in every part of the country, and it was soon made evident that ample funds would be furnished. In fact a total of very nearly 80,000*l.* was ultimately reported to the commissioners as subscribed, though only 67,896*l.* were paid into their bankers—upwards of 11,200*l.* having been somehow absorbed in the several localities as expenses. On the 21st of February, the commissioners were able to make a public announcement of the general plan of the exhibition, and to communicate the royal permission to hold it in Hyde Park.

The site granted for the building was on the south side of Hyde Park, between Kensington Drive and Rotten Row. The commissioners announced that the building would cover an area of from 16 to 20 acres; that it must be ready for the reception of goods by the 1st of January, 1851; that from that day to the 1st of March following goods would be received; and that the Exhibition would be open to the public on the 1st of May, 1851. In March 1850 the Building Committee appealed to architects and engineers to assist them with sketches and suggestions as to the form and general arrangements of the building required for the Exhibition. This appeal was responded to by a large number of professional men, including several foreign architects. The commissioners, however, were unable to recommend any one of the designs for adoption, and ultimately Mr. (now Sir Joseph) Paxton proposed an entirely new plan, that of a vast building of iron and glass resembling in its general principles the great conservatory he had constructed for the Duke of Devonshire at Chatsworth. With the general public it from the first became popular, and as soon as the contractors, Messrs. Fox and Henderson, undertook its erection upon terms which removed all doubt of its economy as well as practicability, the commissioners determined upon adopting it, and accepted Messrs. Fox and Henderson's tender. They were to receive 79,800*l.*, and the materials of the building were to remain their property.

From this time all proceeded rapidly and smoothly. The contract was signed on the 26th of July; on the 30th the contractors obtained possession of the site; on the 26th of September the first column of the building was erected, and on the 4th of December the first rib of the transept was raised; by the 31st of December the building was sufficiently advanced to allow of a lecture being delivered within it to the members of the Society of Arts; and on the 3rd of February, 1851, the completed building was formally handed over to the Executive Committee.

Its entire length was 1851 feet—its breadth 408 feet, with an additional projection on the north side, 936 feet long by 48 wide. The central portion was 120 feet wide by 64 high; on either side of this was another portion 72 feet wide by 44 high; and the north and south portions were 72 feet wide by 24 high. The whole building, from the ground-plan to the ridges of the roof, was a repetition of certain regular forms; and, one portion having been first thoroughly modeled, was a matter of simple arithmetical calculation, and consequently from the hour when the contractors commenced their work, from the simplicity of the plan and the singularly small number of castings required, all the parts were prepared and adjusted to each other with almost mechanical regularity and precision. The colouring of the building was entrusted to Mr. Owen Jones, already well known by his works on the Alhambra. How admirably the building answered its purpose, what new and elegant combinations of form, light, and shade and colour, both the exterior and interior offered to the eye, or what a magnificent and surprising appearance it presented as a whole, whether regarded externally, or when, looking down its unrivalled vista, with its rich and varied contents, from one of the end galleries, few of our readers need to be told.

As soon as provision had been made for the building, the commissioners turned their chief attention to the means necessary for obtaining its contents. The outline of an elaborate system of classification, drawn up by Dr. Lyon Playfair, was issued, showing what a wide range of articles was sought to be brought together under the title of 'Objects of Industrial and Productive Art.' The whole was arranged under four great sections: Raw Materials, Machinery, Manufactures, and Fine Arts; and these were divided and subdivided into a vast number of classes and smaller divisions. To facilitate the collection of the objects, and to serve as ready means of intercourse between the producers and the commissioners, district committees were formed in all the principal towns and manufacturing localities, by whom all the arrangements respecting the allotment of space in the building and the transmission of the goods were conducted. Formal communications were made to the various foreign governments, as well as to the governors of British colonies, by most of whom commissioners were appointed to conduct the operations in those countries required for their adequate representation in the great undertaking. And so judicious were these several arrangements, that though from almost every country in Europe—from almost every state in the North American Union—from the republics of South America—from each of our own wide-spread colonies—from India, Egypt, Persia, and even from the Society Islands, specimens more or less bulky, valuable, and numerous were sent, the numbers were comparatively few that reached their destination materially later than the date at first fixed for their arrival. Considering the entire novelty of the whole proceeding, the immense difficulty there must have been in many instances experienced in getting the collections together, the little knowledge that a large proportion of the contributors could have had of the extreme importance of punctuality, as well as their comparative want of interest in the success of the scheme, and the various physical as well as conventional obstructions which had to be encountered, this must, we think, be regarded as by no means one of the least remarkable circumstances connected with the successful issue of the whole.

Of the actual number of objects exhibited no record was kept. Of their value, many wild guesses were hazarded during the continuance of the Exhibition; the commissioners state in one of the appendixes of their Report that, taking in each case the owner's estimate of the value of his possession, the gross value of the articles exhibited—the famous Koh-i-noor being alone excluded from the reckoning—was under two millions (1,781,929*l.* 11*s.* 4*d.*). The total number of exhibitors was about 15,000.

The Exhibition was formally opened by her Majesty, on the first of May, 1851; it remained open 144 days, being finally closed on the 11th of October. The entire number of visits paid to the Exhibition was 6,063,986, being a daily average of 42,111. This average was not reached till June, but from that time till the close of the Exhibition there was comparatively little variation till the last week, when the average was doubled. The number of visitors during this week was so extraordinary that we are tempted to set down the figures in detail. Monday, October 6th, 107,815; Tuesday, 109,915; Wednesday, 109,760; Thursday, 90,813; Friday, 46,913; Saturday, 53,061.

The six million visits paid to the Exhibition plainly indicate but very roughly the actual number of visitors. Some persons went doubtless ten or even twenty times during the season, a very large proportion went twice. After weighing carefully the probabilities of the case, the authorities arrived at the conclusion that the probable average of visits would be about three, and that consequently about two millions of persons visited the Exhibition. Further, an attempt was made to arrive at the number of *foreign* visitors; and this inquiry led to the unexpected result that not much above 40,000 foreigners visited England beyond the usual annual number of about 15,000. As concerns London and country visitors, an inference was drawn that the number of persons who came from the provinces to view the Exhibition slightly exceeded a million: roughly, we may say that the Exhibition was visited by about a million of the inhabitants of London, the same number from the provinces, and about 50,000 foreigners.

The details of the jury awards do not come within our present object; but the following are the general results, as affording materials for comparison. There were 166 "Council Medals," 2876 "Prize Medals," and 2042 "Honourable Mentions," making a total of 5084 honorary distinctions of all kinds. If we take the exhibitors at the estimated number of 15,000, about one-third were deemed worthy of some kind of recognition. Of the total number, 2039 were taken by exhibitors belonging to the United Kingdom, and 3045 by foreign exhibitors. Our foreign guests occupied about two-fifths of the space, and took off three-fifths of the honours. The greatly-coveted "Council-Medals" were awarded in the ratio of 79 to British and 87 to foreign exhibitors; the "Prize Medals," 1244 British and 1632 foreign; the "Honourable Mentions," 716 British and 1326 foreign.

In relation to different classes of exhibited articles, there were a few striking and instructive facts. In machinery, in manufactures in metal, and in glass and porcelain manufactures, the British exhibitors gained more prizes than all the foreigners combined. In textile fabrics, in fine arts, and in miscellaneous manufactures, the foreign exhibitors took off the honours in the ratio of about three-fifths to two-fifths British. But in the section of raw materials for food and manufactures, the foreign exhibitors gained nearly *four times* as many prizes as the British (988 to 262). The great honours, the Council Medals, were very unequally distributed as regards the classes of exhibited articles; for out of the whole number of 166, no less than 88 (more than one-half) were awarded for machinery alone. This is a significant fact; showing that the Juries, or rather the Council of Chairmen, were not deterred by the gorgeous display around them from doing justice to the great working agencies by which modern wealth is produced.

We must devote a paragraph to the Financial results. The receipts at, and in relation to, the Exhibition, by which it was made a self-supporting concern, were truly remarkable. The total receipts amounted in round numbers to 506,000*l.*, that amount being thus made up: subscriptions, 67,800*l.*, admission fees 425,000*l.*, casual receipts (that is, refreshment and catalogue contracts, royalty on medals, washing-rooms, &c.) 13,200*l.* The total expenditure connected with the Exhibition was about 330,000*l.*, leaving a surplus of 176,000*l.* in the hands of the commissioners; but the final balance, including interest on Exchequer Bills and additional small receipts was 186,436*l.* How to apply this large surplus was a most important question, and they arrived at the conclusion that instead of applying it to any purposes of a temporary, partial or local character, they could in no way so properly act in the spirit of the pledges held out to the public as by assisting in carrying out a comprehensive scheme which should have for its object to "increase the means of industrial education and extend the influence of science and art upon productive industry." Properly to carry into execution any comprehensive scheme would require the liberal co-operation of the public and the government. The sum in the hands of the commissioners would go but a small way towards meeting the requirements of the case. It would suffice however to prepare the ground, and they determined so to employ it, leaving it to the public to complete the work when its importance and necessity shall have become fully understood and appreciated.

Acting on the suggestions of this report, the government in the speech from the Throne at the opening of the session of 1852-53 invited the "aid and co-operation" of parliament in promoting a "comprehensive scheme" for the advancement of the Fine Arts and of Practical Science, which was in effect the scheme of the commissioners. After some discussion the House of Commons voted the sum of 150,000*l.* towards the purchase of a site on which a National Gallery and Museum might be erected, and which should be available for the other purposes indicated. An equal sum was provided by the commissioners out of the surplus remaining at their disposal. The land purchased by the commissioners consisted of the well-known Gore House estate of 21 acres, situated nearly opposite the site of the Exhibition of 1851; the Villars estate of 48 acres, and some other adjacent land, which "were deemed indispensable for the completeness and development of the capacities of the property." Altogether it formed a compact estate of about 86 acres, its extreme length being half a mile, its average width a quarter of a mile. The commissioners were anxious to secure other adjoining property to the extent of about 80 acres then obtainable, making in all about 170 acres, but the Government demurred, and the opportunity was lost, it being speedily purchased for building purposes. For the completion of the purchases the government subsequently obtained an additional vote of 27,500*l.*; and the commissioners, having obtained the necessary powers from parliament, have formed upon the estates lines of road, sewers, &c., retain, in their hands a balance for the purpose of meeting current expenses and providing for contingencies. The commission itself has been incorporated as a permanent body, and certain members of the government are now *ex officio* members of it.

The "comprehensive scheme" of the commissioners proposed eventually to bring together, upon the locality they have purchased, all the existing metropolitan institutions, whether dependent on government or on private support, which have in view the advancement of science and art in their various branches, and to "establish a central point of union for those who in so many ways devote their energies to the same ends, especially in respect to the practical application of science and art to productive industry." But the commissioners have been doomed to see their scheme reduced to much humbler dimensions than that in which it at first presented itself to their imagination; their projects relating to the National Gallery, the British Museum, the National Botanic Collection, &c., have not down to the present time (Jan., 1860) been acted upon. Nevertheless a very definite advance has been made. By manufacturers and artisans, and by general public, as well as by the commission, the great importance of the systematic art instruction is now generally admitted. A new department of the government has been created, whose special duty is the promotion of Industrial Art and Science; and to which was intrusted the direction of all previously existing government scientific and art institutions, and the encouragement of all local institutions of a similar order. It does not fall within the scope of the present article to trace further the operations of the commissioners or the department. [SCIENCE AND ART, DEPARTMENT OF.]

Dublin Exhibition of 1853.—The Crystal Palace of Hyde Park—perhaps (on various grounds) the most world-renowned building of the present century—passed into the hands of Messrs. Fox and Henderson after the close of the Great Exhibition; they sold the materials to a joint-stock body—the Crystal Palace Company. By this company nearly *one million and a half sterling* has been expended on the Crystal Palace and grounds at Sydenham; but it does not fall within the limits of the present article to notice the exhibition at Sydenham, however remarkable in many respects it may be. We pass on therefore to notice the Dublin Exhibition of 1853, which, although occasioning a loss to its projectors, brought well-deserved credit to Ireland and the Irish. The general principle of international exhibitions having just been pretty fully treated, we shall only present here a mere outline.

The Royal Dublin Society had long been accustomed to hold triennial exhibitions of Irish arts and manufactures at their house in Merrion Square. The city of Cork held a similar exhibition in 1852. The pleasure afforded in both of those cities, coupled with the great success of the Hyde Park Exhibition in 1851, led to the suggestion of some more extensive scheme for the year 1853. Mr. William Dargan, a wealthy and liberal railway contractor, wrote to the Dublin Society, proposing that a large exhibition building should be constructed on the lawn in front of the Society's house; that a special executive committee should be appointed to manage a grand exhibition; that he himself would advance the sum of 20,000*l.*; that he would take the building at a valuation after the close of the exhibition; that if, after payment for the building and all other expenses, the proceeds of the exhibition should not amount to 20,000*l.*, with interest thereon at 5 per cent., he should receive the proceeds, less all the expenses incurred, but that if the proceeds should be more than equivalent to all these claims, the surplus should remain at the disposal of the committee. This liberal offer was at once accepted, and a committee appointed. The committee advertised for plans for a building, and selected from a large number one which was sent in by Mr. Benson. Suggestions being from time to time made for various extensions of the plan, Mr. Dargan, in the same generous spirit as before, increased his liability to 40,000*l.* The building was constructed during the winter and spring. It comprised a central hall, 425 feet long, 100 feet wide, and 105 feet high, with a waggon-vaulted roof, terminated by domes at the two ends, and lighted by skylights on the top. There were lesser halls on either side of this central hall, and still smaller halls bounding the building on the north and south. There were, in addition, several subsidiary halls and galleries; and all were tastefully painted in coffered panelling. On the 12th of May, 1853, the exhibition was opened by the lord lieutenant. Nothing but the desire of keeping faith could have warranted the opening on that day; for, although the building itself was nearly finished, the contents and arrangements were very incomplete. Indeed, the collection was constantly being added to throughout the whole duration of the exhibition.

The building contained a fine collection of pictures; contributions in art and manufactures from several foreign countries; a fair amount of specimens illustrative of English and Scottish industry; and a larger collection than had ever before been made of the produce, manufactures, and art of Ireland. That Ireland's contributions did not show such an advanced degree of excellence as those of the sister-country was to be expected; but they had this value,—that they marked the state of things in 1853, and that, by showing wherein the industrial deficiencies of the country chiefly lay, they suggested the road to improvement. The exhibition building cost 48,000*l.* The value of the contents, at the fullest period, was roughly estimated at somewhat over 500,000*l.*, of which the fine arts specimens (paintings, sculptures, and mediæval productions) were set down at 200,000*l.* The exhibition closed on the 29th of October. The result, however, gratifying in many ways, was far from successful financially, seeing that a heavy loss fell on Mr. Dargan.

New York Exhibition of 1853.—It was perhaps unfortunate for both cities that the exhibitions at Dublin and New York took place in the same year; for this coincidence distracted the attention of many who might have been willing to contribute. In both cities the exhibition took place without the direct aid of the government; but New York was not so fortunate as Dublin in obtaining the noble offer of one man to bear whatever loss might occur. The American visitors to the Hyde Park Exhibition took home with them recollections which led them to wish for something of a similar character in their own country. Many conferences were held, chiefly at New York; and towards the close of 1851 the municipal authorities of that city agreed to grant, to a joint-stock company established for the purpose, a lease for five years of a plot of ground called Reservoir Square, close to the magnificent reservoir terminating the Croton aqueduct. The ground was to be rent free, on two conditions: that the exhibition building constructed thereon should be of iron and glass; and that the fee of admission for visitors should on no days be higher than half a dollar (2*s.* 1*d.*). The legislature of the state of New York granted a charter of incorporation to the company; and the customs authorities agreed that the building should be regarded as a bonded warehouse, into which articles might be brought duty free during the continuance of the exhibition. Thus armed, the directors of the new company met in March, 1852; they announced an issue of shares to the amount of 300,000 dollars (60,000*l.*); this capital was readily subscribed, and the total was afterwards raised to 500,000 dollars (about 100,000*l.*).

It was soon found that the choice of locality was bad; the spot was three or four miles from the heart of the city, and comprised an area of only about 450 feet square,—far too small for the purpose in view. The directors advertised for plans. Sir Joseph Paxton sent in one, which was much admired for its beauty, but which was unsuited to the shape of the ground. Among many competitors, a plan of Messrs. Gildermeister and Carstensen was accepted. The building was in the shape of a Greek cross, about 400 feet in each direction, with arms 150 feet wide. In the centre was a circular space 100 feet in diameter, covered by a dome. Each arm of the cross comprised nave and aisles, with galleries over the latter. The most attractive part of the interior was the beautiful dome, 123 feet in diameter, framed on 32 very ornate ribs of iron, and having 32 windows of stained glass alternating with the ribs. The windows in the main building were rendered translucent by the use of glass having a thin vitrified layer of white enamel. There were octagonal towers at the four corners of the cross, and twelve staircases to lead from the ground-floor up to the gallery. The exterior was painted bronze-colour, slightly relieved with gold; the interior was mostly cream-coloured, picked out with the three positive colours—red, yellow, and blue. In the struggle for more space, the directors found themselves able to construct a strip of building, 450 feet by 75, on one side of the Greek cross.

Agents were sent over Europe to invite contributions; and the builders did their best to finish the structure by the 1st of May, 1853, the day appointed for the opening; but numerous difficulties supervened, and the opening did not take place till the 14th of July. This delay was disappointing to the exhibitors and the public, and disastrous to the company, seeing that it seriously limited the number of summer days available for the exhibition. Even on the day last named the whole arrangements were in a chaotic state; the "machinery in motion" and the picture-gallery were not opened till September 1st. The articles were grouped in 31 classes (one more than at the London Exhibition, by separating the musical from the philosophical and horological instruments); but the size and shape of the building did not afford much facility for geographical grouping—so remarkable a feature in Hyde Park. There were prize medals, and jurors to award them; but the juries were 17 instead of 31. There were about 4800 exhibitors, of whom rather less than one-half belonged to the United States; the rest being foreigners, mostly from Europe. The Exhibition was open 119 days. During this time the receipts, from visitors, sale of catalogues, &c., were 340,000 dollars, or about 71,000*l.* This result was very unsatisfactory. The company spent 540,000 dollars on the building, 100,000 dollars on the fittings and furniture, and 250,000 dollars in miscellaneous outlay, during a period of more than two years. The final cost, for everything, was very little short of 200,000*l.* It absorbed all their share capital, all the receipts from visitors, and two loans raised at interest. What they had *per contra* was the exhibition building, and the liberty to use the building and its site for exhibition purposes during a further period of four years.

The British government sent over commissioners to the New York Exhibition, chiefly for the purpose of examining and reporting on the quality of the articles exhibited. The commissioners, like the exhibitors, were wearied by the delay in opening; and they fully admitted that the display would have been both superior and more remunerative if the contractors could have finished the building in due time. By far the most valuable feature was the exhibition of machines made in the United States; these were extensive, varied, and excellent, and attracted much attention on the part of the English visitors. The British government purchased numerous machines used in the manufacture of rifles, pistols, and carbines.

Paris Exhibition of 1855. The French government soon after the close of the grand display in London, resolved on the holding of an international Exhibition at Paris, based upon similar principles; but various circumstances prevented the realisation of the scheme until 1855. The whole cost was borne by the government, instead of by visitors' payments, as in England. The management was confided to a special commission appointed by the Emperor. The building constructed, however, in the Champs Elysées, and called the *Palais de l'Industrie,* belonged to a joint-stock company; it was commenced on the understanding that the government would guarantee 4 per cent. on the outlay, together with a share in the surplus profits; but as a surplus never appeared, the whole of the admission money paid by the visitors went to the company. Among the commissioners were comprised many names of European reputation — Elie de Beaumont, Dupin, Gasparin, Ingrés, Leplay, Lesseps, Merimée, Chevalier, Morin, Poncelet, Regnault, Sallandrouze, Visconti, &c. One of the points of difference between the London and Paris Exhibitions was the admission of paintings and engravings into the latter. In addition to France and her colonies, 53 foreign states, and 22 colonies belonging to those states, sent articles for exhibition. In the latest edition of the official catalogue, there appeared the names of 20,839 exhibitors; of whom 10,691 were French, and 10,148 foreign. England and her possessions figured for 2574. It required 6400 packages, weighing 1300 tons, to take the British goods only to Paris.

The building was not of a compact and uniform kind, like Paxton's palace of glass in London. There was a Palais de l'Industrie, and there was a Palais des Beaux Arts; there was a building called the Panorama; and three smaller buildings were subsequently added, for the reception of agricultural implements, carriages, and cheap articles. There were also exhibiting spaces in open ground; and thus it happened that the articles exhibited occupied altogether seven or eight different localities. The main building was of stone, brick, and glass, much more costly than the Hyde Park building, and intended to be more permanent; it was, however, only 800 feet long by 350 wide. Although the block of buildings was pierced by 400 windows, it was not so well suited as the glass palace in Hyde Park for the display of goods. When it was clearly seen that this building would be too small, two others were hastily erected; one, for machinery, was a gallery of immense length running along the north bank of the Seine; and the other, for a picture gallery, or Palais des Beaux Arts, was a wooden building in the Allée des Veuves. Altogether, the various buildings, together with the other expenses connected with the undertaking, involved the very large outlay of one million sterling; but Mr. Cole, one of the British commissioners, was informed, on good authority, that this sum was more than equalled by the extra expenditure of foreigners in Paris during those months.

Owing partly to the substantial nature of the main building, and partly to difficulties between the government and the owners of the Palais de l'Industrie, the exhibition was not open till the 15th of May; it was closed on the 15th of November. The total number of visits paid was 4,533,464 (the Hyde Park number was about one-third more). About 40,000 British subjects were among the visitors. Unlike its English predecessor, the exhibition was open on Sundays as well as week days; Sunday was, indeed, the "peoples' day," on which the charge for admission was only 20 centimes (2*d.*); Friday was a special day, on which the charge varied from 2 to 5 francs (1*s.* 8*d.* to 4*s.*), at different times during the autumn; on the other five days of the week the charge was uniformly 1 franc (10*d.*). On one particular Sunday (May 27th) the exhibition was thrown open gratuitously. There was only one kind of season ticket, charged at 50 francs (2*l.*). Two sections of the exhibition,—the Palais de l'Industrie and the Palais des Beaux Arts—were distinct, and subject to separate charges for admission; the visitors to the former were four times as numerous as those to the latter.

The articles were classified nearly in the same way as in London, there being in each case 30 classes altogether. To apportion medals to deserving exhibitors was the difficult labour of nearly 400 jurors, of whom about half were named by the French government, and the other half by foreign governments. The foreign jurors found this work to be a great tax on their time, seeing that they were thus engaged during the greater part of three summer months. There were four classes of medals distributed, and one grade of "honourable mention."

In relation to the British portion of this exhibition, it may be stated that the government placed the sum of 50,000*l.* at the disposal of the Board of Trade, to assist in defraying the expenses incurred by the exhibitors, and in preparing reports on the results of the exhibition. These reports have since been published by the government at a very cheap rate: they are about 30 in number, and were drawn up by some of the English jurors who had taken an active part in the onerous labour of examining the articles exhibited. The three portable volumes containing the reports constitute a valuable addition to the literature of the industrial arts.

Zollverein Exhibition at Munich.—The example set in 1851 has led to the organisation of many other industrial displays in the United Kingdom and on the Continent. We may name, as a few of these, a New Brunswick Exhibition in 1853; a Madras Exhibition of native industry in the same year; an Exhibition of German Industry at Munich in 1854; and an Art Exhibition at Edinburgh in 1857. From among these, it must suffice to give a few figures concerning the Munich Exhibition. An iron and glass building was constructed at a cost of 90,000*l.* It was 800 feet by 280, 87 feet high, and had 250,000 square feet of flooring. There were 6800 exhibitors, belonging to 33 Zollverein states, and the goods they sent, distributed into 12 classes (instead of 30 as in England and France), were roughly valued at 1,500,000*l.* The exhibition was open from the 15th of July to the 15th of October, at an admission fee varying from 4½*d.* to 1*s.*, English. The undertaking would probably have entailed a loss under any circumstances; but a visitation of cholera, in the last months of the autumn, so thinned the number of visitors, that the Bavarian government lost 200,000*l.* by the exhibition.

Manchester Art-Treasures Exhibition.—Although not exactly an international exhibiton, the Manchester Exhibition was so comprehensive in character, and so exceptional in its leading features, that it is fully entitled to a place here.

The Manchester Exhibition was the child of the French Exposition Universelle of 1855, as that was of the Great Exhibition of 1851: it differed from both in being an exhibition solely of artistic objects sent by their possessors, and not by producers or by dealers. The project was inaugurated at a meeting of Manchester gentlemen on the 26th day of March, 1856. The scheme was favourably received; an ample guarantee fund readily provided; the Queen and the Prince Consort gave their hearty support to the undertaking; and with few exceptions —and these in some cases forced ones, the effect of entails, &c.—the owners of works of art responded cheerfully and freely to the appeal. A building was erected at Old Trafford, about two miles from the centre of the city, and readily accessible by railway as well as omnibus, from a design by Mr. Salomons, in conjunction with Messrs. Young and Co., of Edinburgh, the contractors. The exhibition was formally opened by the Prince Consort on the 5th of May, 1857, and remained open till the 17th of October.

In its general plan the building was a parallelogram of 660 feet by 200 feet, with low projecting towers and attached corridors at the east or entrance end, and refreshment-rooms and offices built out from the sides. With the exception of the entrance front, which was of brick, the exterior of the building was constructed entirely of corrugated sheet-iron, affixed to a cast-iron framework; the interior being lined with wood. The entire structure covered an area of about 130,000 square feet, and cost somewhat over 30,000*l.* The interior consisted of a central hall and two side aisles, with transepts near the western end; at the western end a gallery extended round the transepts, and across the end of the building, and at the eastern end one was carried across the front. The central hall, which was 632 feet long and 104 feet wide, was divided into three sections by a series of slender coupled columns. The roof consisted of a semicircular span of 56 feet, springing from the columns, with hipped side spans 24 feet across. The side aisles, or picture galleries, were 432 feet long and 40 feet wide, and were spanned by a semicircular roof 50 feet high to the crown of the arch. A water-colour gallery at the western end of the building was 200 feet long by 24 feet wide.

The walls of the central hall were covered with portraits of celebrated English personages. Below these were cases filled with various articles of ornamental art, while along the body of the hall were ranges of upright cases containing larger, rarer, and more costly specimens of a similar kind. The general collection of modern sculpture was also arranged in a double series the entire length of the central hall. The Meyrick collection of armour, with choice examples from other repositories, and the entire Soulages collection of antique furniture, &c., occupied spaces near the western end of the hall. The South Aisle was devoted to Paintings by the Ancient Masters, the north to pictures by English painters. A room beyond the transept on the south side was occupied by the noble contribution of the Marquis of Hertford, and a miscellaneous collection of cabinet-paintings of the Dutch and Flemish schools. A corresponding saloon on the north side contained the Oriental Museum. Beyond these, extending across the western extremity of the building, was a long room which, with two smaller rooms, was entirely occupied by water-colour pictures. The western gallery was filled to overflowing with the collection of miniatures, drawings by ancient masters, engravings, etchings, woodcuts, lithographs, photographs, and architectural drawings. Pictures, mostly by modern masters of foreign schools, occupied the space afforded by the eastern gallery; and finally, along as much as was available of the wall of the corridor stretching towards the railway station, were hung paintings by the old masters, for which room could not be found in the south aisle.

The number of paintings of all kinds by ancient masters was 1115, by modern masters 689. Of British portraits there were 388; of miniatures and enamels there were 59 cases, but several of the cases contained numerous examples. The water-colour drawings numbered 969. Of modern sculpture there were 160 specimens, all being in marble except about a dozen which were in bronze. The original sketches and drawings by the old masters numbered 260; the engravings in line 937; in mezzotinto 161; the etchings 246; besides which there was a considerable number of woodcuts, and plain, tinted, and chromo-lithographs, and about 600 photographs. Finally, the museum of ornamental art comprised no fewer than 17,000 articles—some whose value was to be reckoned at hundreds of pounds each, others of marvellous beauty though of inferior pecuniary value, and others again whose only value lay in their rarity.

The paintings by the old masters, which formed the principal feature of the exhibition, were arranged as far as practicable in chronological order: the Italian pictures occupying the south wall, those of Germany and the Netherlands the north wall; the Spanish pictures being placed in the vestibules. For completeness and value such a collection was probably never before brought together, comprising as it did characteristic examples of almost every school, and extending over the entire range of the art from its dawn in the 13th to its decline in the 17th century. Of English paintings the collection, if less important was no less instructive. It was indeed the only attempt that had been made to exhibit a collection of English pictures which should suffice to give a tolerably complete view of the rise, progress, and present state of painting in England. And what was done in the south aisle for English oil painting was in the western rooms accomplished for English painting in water colours; the series showing in fact the whole history of the art by means of first-class examples. Of the British portrait gallery we have already spoken.

The collection of original drawings and sketches by the old masters contained 260 choice specimens by some of the chief artists of all countries; while of the collection of engravings it is enough to state, in the words of the catalogue, that "This was the first time in the history of the art of engraving at which an attempt was made to show the public generally, at one view, a complete chronological series of prints from the commencement of the art up to the present time," some of the examples being among the choicest of the most highly-prized prints of the greatest engravers of every country.

The Museum of Ornamental art—the most comprehensive and richest collection of the kind that probably was ever brought together, consisted of the costliest and most exquisite specimens of mediæval goldsmiths' work, arms, armour, and every kind of artistic metal work; majolica, Dresden, Sèvres, and other pottery; Venetian and other rare glass; ivory carvings; bronzes, and terra cotta sculpture, &c. &c., with extensive collections of Oriental ornamental produce formed by the Queen and the East India Company; and entire collections selected as characteristic of the treasures in ornamental art, of the British and South Kensington Museums; the entire Soulages collection; and the Mayer collection of British, Celtic, and Anglo-Saxon antiquities.

The Exhibition, during the five months it remained open, received above a million and a quarter visits (1,335,915)—one million (1,053,538) by payment at the doors, the rest by season-tickets. The receipts from all sources amounted to 98,500*l.*, the entire expenditure was a few thousands more, but it was pretty nearly covered by the sale of the materials of the building.

EXILE. [Banishment.]

E'XODUS, THE BOOK OF, is the second of the Pentateuch, or Five Books of Moses, and derives its name from the principal event recorded in it, namely, the departure of the Israelites from the land of Egypt, which, in the Greek Septuagint translation, is expressed by the word éxodus (Ἔξοδος), that is, the going out. In the original Hebrew it is named, according to the usual Jewish mode, from the initial words, ואלה שמות *ualh shmut*, or, as read with the Masoretic points, Ve-elleh shemoth, "and these are the names." The king, Pharaoh (a general Egyptian appellation of royalty), for whom the Israelites built the treasure cities, and by whom their male children were ordered to be drowned (chap. i.), is usually considered by the commentators to be Rameses, the eldest son of Sesostris; and the Pharaoh whose army perished in the Red Sea (xiv. 27) is supposed to be his son and successor, Amenophis the Second, or according to others, the Third. The Mosaic exodus is noticed by several ancient writers, but with brevity and apparent contempt. The Egyptian historians, Manethon and Chæremon, as cited by Josephus ('Against Apion,' l. i., c. 9, 11, 12), state that 250,000 leprous people, and others afflicted with contagious diseases, were banished from Egypt ('Exod.' xii. 39), "they were thrust out of Egypt" by king Amenophis; and that their chief was a priest of Heliopolis named Moses, who furnished them with a system of religion and laws. (See a similar account in Josephus, 'Hist.,' l. v. c. 34; Tacitus, 'Hist.,' l. v. c. 3; Diodorus Sic. 'in Photii Biblioth.,' l. xxxiv.; Justin, l. xxxvi. c. 2.)

The period over which the history in the book of Exodus extends consists of 145 years, that is, from the death of Joseph (B.C. 1635) to the formation of the tabernacle in the desert of Arabia (B.C. 1490), one year after the exode in the year B.C. 1491. Mr. Horne, in his 'Introduction to the Bible,' adopts the general opinion of commentators that the book was written by Moses, yet he thinks that it cannot be determined at what time of his life; but, as it is stated (xvi. 35) that "the children of Israel did eat manna 40 years until they came unto the borders of the land of Canaan," that is, on the banks of the Jordan, opposite Jericho, when and where Moses died ('Gen.' xxxiv.), and, "as things cannot be historically related," as Mr. Horne observes, "until they have actually taken place," it is evident that, if Moses is the author, he must have written it immediately before his death (B.C. 1451). De Wette, and other writers of the rationalistic school, have earnestly endeavoured to show that Moses could not have been the author; but besides the express declaration of Moses himself, that he "wrote all the words of the Lord" ('Exod.' xxiv. 4), Hengstenberg, Havernick, and others, English as well as German, have very sufficiently controverted their objections, and there have been constantly increasing verifications among the discoveries in Egyptian antiquities. It must be observed however that, among biblical critics and chronologists, a great difference of opinion exists as to what date should be assigned to the departure of the Jews from Egypt.

EXORCISM (ἐξορκισμός), the form of adjuration, or charging upon oath, by which evil and malignant spirits are subjected to command, or driven away: from the Greek *exorkizen* (ἐξορκίζειν). See Joannis Wieri, 'De Præstigiis Dæmonum et incantationibus ac veneficiis Libri v.,' 8vo., Bas. 1566 and 1583; and the 'Manuale Exorcismorum,' by Maximilian ab Eynatten, 8vo., Antw., 1619.

EXOSMOSE. [Endosmose; Osmose.]

EXOSTOSIS (ἐξόστωσις) a swelling or tumour of a bone. This term has been applied very generally to all tumours of the bones, whether they partake of the characters of osseous structure or not. This led to the distinguishing these swellings into true and false: the former including true osseous structures; the latter the various forms of cartilaginous tumour, spina ventosa, and those diseases of the periosteum and bone called by Sir Astley Cooper periosteal and medullary exostosis. True exostosis is in fact nothing more than an hypertrophy of the tissues which constitute the bone. Hypertrophy of a bone may arise from natural causes, and is produced by anything which constantly increases the action of a part. It is thus that the same actions which increase the size of the muscles of a blacksmith's arm and a dancer's leg will also be attended with an increased development of the bony attachments of the same muscles. During rapid growth it sometimes happens that one part of a bone grows faster than another, from some increased facility of nutrition in the part, and the consequence is an exostosis. This often occurs in the clavicle of children, but requires no treatment, as subsequent growth removes the deformity.

The more frequent cause of an exostosis, which does require treatment, is the production of increased action of the part by the application of some stimulus. It is difficult frequently, in bones, to trace the increased action to the true cause. It sometimes, however, follows a blow; and some persons are so predisposed to take on this form of action, that slight injuries are followed by exostoses. The structure and density of exostoses vary much. Sometimes they exhibit a light cellular structure, like the cancellated structure of bones, and are frequently much lighter and more cancellar than is ever observed in this structure in its normal development. At other times the structure of the exostosis is much harder than common bone, and possesses all the characters of ivory. The cancellated structures sometimes attain a considerable size, but the ivory exostoses seldom exceed the size of a bean. The first are most common on the long bones, as the femur, tibia, humerus; the last on the cranium, and bones of the face. Sometimes the increased action of the tissue extends to the whole bone, and every part is enlarged. Remarkable examples of such a thickening of the whole of the cranium occur in the museums of the Royal College of Surgeons and University College.

Exostoses are easily distinguished from other swellings by their being fixed and immoveable, and at first unattended with any pain or inconvenience. They are also distinguished by the slowness of their growth. Where exostoses are situated on parts of the skeleton in which they do not interfere with other organs, they may be left to themselves. Situated behind the knee-joint, they have been known to interfere with the action of the flexor muscles. The growth of an exostosis from the os-pubis has, by its pressure, rendered the urethra impervious. An exostosis of the femur has been known to obliterate the femoral artery; in the orbit, to produce displacement of the eye. Cases are recorded in which an exostosis of the cervical vertebræ has obliterated the subclavian artery, and, extending backwards from the lower jaw, has produced a fatal impediment to respiration by its pressing on the larynx. No kind of external treatment is beneficial in any of the forms of exostosis; and when, on account of their position, it is thought right to treat them, they must be removed. The operation consists in sawing or cutting away the bony tumor, which may be done by a trephine, Hey's saw, or Liston's cutting pliers. Of course this operation should only be performed when it can be done without danger to neighbouring organs. Even when the whole of the projection cannot be removed, it will often be found of advantage to take away a part.

(Cooper, S., *First Lines of Surgery*; Cooper, S., *Dictionary of Surgery*; Mayo, *Outlines of Human Pathology*; Liston, *Elements of Surgery*.)

EXOTERIC and ESOTERIC (ἐξωτερικός and ἐσωτερικός), literally "external" and "internal," were two terms used in reference to the writings and doctrines of many of the ancient Greek philosophers. The general distinction between the classes of works called by these respective names is this: the "exoteric" were those writings which were in a more popular form; the "esoteric," those which were written in a scientific and more exact form. The "esoteric" would of course contain a true investigation of principles as then understood; the "exoteric" would exhibit philosophical systems in such a form as the mass were able and willing to receive. The "exoteric" writings consequently accommodated themselves to popular prejudices and superstitions, this being the only safe way in which a certain amount of philosophical truth could be conveyed to the vulgar. The "esoteric" writings and doctrines were reserved for those who were far enough advanced to understand them, and to form a just notion as to the prevalent false opinions of the mass of the people. It is important to bear in mind this distinction between "exoteric" and "esoteric" doctrines in forming our judgment of the character and writings of the ancient philosophers. [Aristotle, in Biog. Div.]

EXPANSION. [Heat.]

EXPECTATION OF LIFE, a term applied to the mean or average duration of the life of individuals of any given age. [Life, Mean Duration of.]

EXPECTORANTS (from *ex*, out of, and *pectus*, the chest) are medicinal agents, which, in certain conditions of the system, will, either by promoting or repressing the secretion of the air-passages and of the lungs, facilitate its expulsion. The articles which bear this name differ considerably as to the means by which this end is accomplished. They are chiefly derived from the vegetable kingdom, some being gum-resins, or balsams, of a stimulating quality, while others are possessed of nauseating or sedative properties; vapours also are expectorants, and may be either simple, as that of warm water, or medicated with different impregnations. Vapours alone reach the organs to be affected, and are therefore the only *direct* expectorants; the others being taken into the stomach must operate by sympathy or some other obscure agency.

From the differences in the nature of the substances regarded as expectorants it is clear that they must operate in a very different manner, according to the state of the system, the pathological condition of the lungs, and the stage of the complaint. Great care is necessary in selecting the particular agent suited to each case, and in no set of diseases are greater errors committed by unprofessional persons by an injudicious employment of these agents, than in those of the lungs, from common colds to the more serious and fatal affections of these vital organs. The slight nature of many of the common maladies of the throat and lungs, and the fatality of consumption, which is generally though most erroneously regarded as an affection of the lungs themselves, while it is truly an affection of the whole constitution, have led to a degree of interference with the treatment of diseases of these organs not attempted in any other cases, as the multitude of popular remedies for *coughs, colds*, and *consumptions* attest.

A certain exhalation from the internal surface of the lungs and air-passages constantly goes on in a state of health—any considerable diminution or augmentation of this secretion may require the assistance of medicines to raise it to the proper quantity in the one instance, or to evacuate the superfluity and repress the tendency to its excessive formation in the other. The chief causes which lead to diminished secretion are inflammation and spasm—hence at the commencement of inflammatory affections of the air-passages and of the lungs the inner membrane is dry, and by the stethoscope what is called the crepitating *râle* is heard; in asthma and hooping-cough, while the spasm lasts, there is an absence of secretion, which becomes abundant when the spasm yields.

To obviate these states very different means must be employed from what are necessary in the later stages of an inflammatory affection, or where there was extreme relaxation of the vessels of the lungs, and the exhaled fluid redundant in quantity. One of the terminations of inflammation being by effusion, when the increased action of the vessels has lasted for some time a state of the lungs occurs which is precisely the reverse of what it was before; and an extreme quantity of mucus obstructs the access of air to the blood circulating through the cells of the lungs: if this continue to accumulate, suffocation must follow. Too great an accumulation sometimes takes place, especially in elderly people; not from excessive secretion but from deficient absorption.

These are a few of the different states for which expectorants are used, but much circumspection is required to accommodate the means to the end. Where there is decided inflammation the best expectorants are those which lessen the inflammatory state, such as venesection and nauseating doses of tartrate of antimony or of ipecacuanha, and the inhalation of the vapour of warm water, simple or medicated, by means of Mudge's inhaler. But as the use of any such instrument requires considerable exertion of the respiratory organs, where the inflammation is violent it is inadmissible, as the lungs must be kept in as tranquil a state as possible; but the head may be held over a basin of warm water, the vapour of which will be received by the lungs in the ordinary course of respiration.

When the inflammation has subsided, the more stimulating expectorants may be used. Where there is first spasm hindering secretion, and ultimately an excessive exhalation which must be cleared away, a combination of a sedative or antispasmodic medicine with the expectorant is best.

These are the principles which should regulate our choice in the more acute affections of the chest; but as no set of organs are so subject to chronic disorders as the lungs and their appendages, we frequently have recourse to expectorants to alleviate many of the symptoms attendant on them.

Lessening the tendency of blood towards the lungs, and directing it more towards the skin, is of service both in acute and chronic affections of the chest. Hence bathing the feet in water on the first feeling of an attack of cold, followed by antimonials or other diaphoretics, is of much utility, if the patient go into a warm bed immediately; while on the same principle, the use of flannel next the skin is the best preventive, and is indispensable for all delicate persons, particularly if predisposed to diseases of the lungs.

EXPLOSION is the sudden displacement of a considerable volume of air, or of any gaseous particles, accompanied by a loud report.

In the well-known experiment with a glass cylinder having one end covered with a thin bladder tightly bound about it, the column of air incumbent on the bladder suddenly descends into the vessel on the rupture of the bladder when the air beneath is withdrawn by means of an air-pump; and the collision of its particles with one another or with the sides of the vessel produces the vibrations which cause the perception of sound. The particles of steam, in a state of high elasticity, when suddenly liberated by the bursting of the vessel in which they are contained, produce also a loud report by their collision with the atmospherical particles about them, or by the rush of air into the rarefied space which they have quitted. The elastic gases liberated on the application of fire to gunpowder in a tube, and the heat produced at the same time, create a rapid displacement of the particles of the surrounding atmosphere; and these as rapidly falling back into the vacuum within and about the fire-arm, cause a loud report by their collisions. A fulminating powder is the cause of a like explosion being produced, by means of the gases which are set free in consequence merely of the friction of the particles.

The explosions which, in the atmosphere, accompany a flash of lightning, are also ascribed to a similar displacement and subsequent rush of air into the vacuum produced.

For the explosion produced by chemical combinations, see DETONATION.

EXPONENT; EXPONENTS, NOTATION OF. In the algebraical expression a^x, x is called the exponent of a. If we were strictly to preserve the most ancient meaning of the term, x would be called the exponent of the whole symbol a^x: but it is usual to call x the exponent of a, and the logarithm of a^x.

From the time of Descartes it has been usual to employ exponents in abbreviation of repeated symbols of multiplication: but this was only the beginning of a series of extensions which have made the theory of exponents a fundamental part of analysis. Beginning with the simple substitution of a^2 instead of $a \times a$, a^3 instead of $a \times a \times a$, and so on, we have a succession of new symbols suggested by the processes of algebra, namely, that a^1 should stand for a, a^0 for unity, a^{-x} for the reciprocal of a^x, and $a^{\frac{m}{n}}$ for the nth root of the mth power of a. These conventions being made, the common algebraical theory of exponents is complete; and the student will find in works on algebra an account of the manner in which the necessity for these extensions appears. The theory of logarithms flows naturally from this notation and the binomial theorem.

Looking at the notation of exponents in another point of view, we see that a^1, or a, signifying the performance of a certain operation on the unit, a^2, or aa, signifies the repetition of the same operation upon a itself; a^3 denotes the repetition of the same operation upon a^2, and so on. Hence by analogy, whenever, in the higher parts of analysis, ϕx signifies an operation performed upon x, $\phi^2 x$ signifies the repetition of the operation upon ϕx. Thus if ϕx signify $1+2x$, then

$$\begin{array}{llll} \phi^2 x & \text{is} & 1+2\,(1+2x) & \text{or} \quad 3+4x. \\ \phi^3 x & \text{is} & 1+2\,(3+4x) & \text{or} \quad 7+8x, \text{ \&c.} \end{array}$$

It appears by reasoning analogous to that which establishes the meaning of exponents in algebra, that $\phi^0 x$ must stand for x itself. Also $\phi^{-1}x$ must signify the operation inverse to (or which destroys the effect of) ϕx; thus if ϕx signify x^2, $\phi^{-1}x$ must be $\sqrt{x}$. Also $\phi^{\frac{m}{n}} x$ means that operation which performed n times in succession, gives the same result as ϕx performed m times.

The Differential Calculus and the Calculus of Differences furnish striking examples of the notation of exponents. As soon as the student arrives at the higher parts of these subjects, he should pay particular attention to the structure of the notation, and in particular to the meaning of those theorems in which the symbols of operation are separated from those of quantity.

EXPORTS. [IMPORTS and EXPORTS.]

EXTENT (Lat. *extenta*) is a writ of execution (sometimes called an *extendi facias*), which is directed to the sheriff against the body, lands, and goods, or the lands only, of a debtor; and it is also used as signifying the act of the sheriff or officer upon the writ itself.

The king by ancient prerogative is entitled to this writ, either in chief or in aid, for the purpose of obtaining satisfaction of debts originally due to him or assigned to the crown. *The writ of extent in chief* is an adverse proceeding by the king for the recovery of his own debt, and in which he is the real plaintiff. The writ is issued out of the Court of Exchequer; and the sheriff, for the purpose of executing it, may break open the defendant's doors, when purposely closed, either to arrest him or to take his goods. If, however, the defendant cannot be found, or is not meant to be arrested, the sheriff impanels a jury to inquire as to the debtor's lands and tenements, goods, and chattels; and after the inquisition is made, the lands then become bound to the crown until the debt is satisfied. *The writ of extent in aid* is also sued out at the instance and for the benefit of the crown against the debtor of a crown debtor: in this proceeding the king is the nominal plaintiff only. The writ is in effect an extent in the second degree, and in order to obtain it an extent *pro formâ* is sued out against the debtor to the crown, upon which an inquisition is taken; and if it be thereupon found that another person is indebted to him, the Court of Exchequer, on an affidavit to that effect, and also to the effect that the crown debt is in danger, will grant a fiat or warrant for an immediate extent in aid. Under this writ, the body of the defendant may in strictness be taken in execution as well as his lands, tenements, goods and chattels, &c.; but where there are effects sufficient to satisfy the debt, the court seems generally disposed to give the defendant his discharge.

On the return of the writ of extent in chief or in aid to the court whence they are issued, an order is endorsed on the back of it, "that if no one shall appear and claim the property of the goods, &c., mentioned in the inquisition, on or before that day se'nnight, a writ of venditioni exponas shall issue to sell the same." If the produce of the goods sold be not sufficient to pay the debt, the court will make an order for the sale of the debtor's lands under the 25th George III., c. 35.

There are various means of resisting the execution of the above writs, on the ground of informality or want of title in the crown; which may be referred to in the second volume of Mr. Tidd's work on the practice of the superior courts.

Upon the subject of extents for the subject see ELEGIT.

When lands are delivered over to a creditor upon an extent, a reasonable but not the real value is set upon them; and the effect is the same as if the creditor took a lease of the lands until his debt is satisfied.

(Coke *on Littleton;* Tidd's *Practice;* Blackstone's *Commentaries*, Kerr's edition.)

EXTORTION. "Extortion," says Coke (Co. Litt., 368, b.), "is a great misprision, by wresting or unlawfully taking by any officer, by colour of his office, any money or valuable thing of or from any man, either that is not due, or more than is due, or before it is due." It is an offence at common law, punishable by fine and imprisonment at the discretion of the court. Also, money which has been obtained by extortion may be recovered in an action at law. There are various statutes providing penalties for extortion by sheriffs, under-sheriffs, bailiffs, gaolers, clerks of assize, &c.

EXTRACTION OF ROOTS. [Involution and Evolution.]

EXTRACTIVE MATTER. At a period when chemical analysis was less perfect than at present, the term extractive matter was applied to a heterogeneous mixture of matters obtained by treating vegetable substances with water, and then evaporating the solutions to dryness. Improvements in analysis have enabled the chemist to resolve such extractive matter into its constituents, and the term has now become nearly obsolete.

EXTRACTS are medicinal preparations of vegetable principles, obtained in various ways. Sometimes they are merely the juices expressed from the fresh plants, brought by careful evaporation to the consistence of honey, and then more properly denominated *inspissated juices*; at other times they consist of certain principles of the fresh or dried plant extracted by some menstruum in which they are soluble, such as water, proof spirit, vinegar, or ether, and afterwards evaporated, as in the former case. According to the nature of the menstruum employed the extract is called *watery*, *alcoholic*, *acetous*, or *ethereal*. The objects proposed in such proceedings are, to ensure the preservation of the active principles of the plant by removing the fluid in which they are dissolved, or the materials with which they are associated, that have a greater tendency to fermentation or putrefaction; to bring the valuable portion into the smallest possible compass; and to facilitate the administration of them by thus rendering them capable of being made into pills, &c.

The preparation of extracts requires the greatest care. The plants must be in every respect of the best quality, as regards the place of their growth, season when collected, &c., and the evaporation must be conducted rapidly, yet at a low temperature. Orfila found that the excellence of preparations of this kind was always in the reverse ratio of the temperature employed to form them. Mr. Barry effected a great improvement in the mode of preparing extracts by evaporating *in vacuo*. During the preparation, and especially towards the end of the operation, frequent stirring the contents of the evaporating-pan is necessary to prevent burning or decomposition of any portion of the mass. Extracts may also be formed from dried plants, barks, roots, &c., by reducing them to fine powder and macerating it for 24 or 48 hours in sixteen times its weight of water. In general cold water is now employed, but in some cases it is proper to employ warm. The extract of cinchona, prepared with cold water, is less powerful than that prepared with warm.

Extracts are simple or compound, according as they are prepared from one plant or from several different kinds.

This mode of preparing vegetable principles is generally unsuitable where a volatile oil is the active agent, unless great care and a very low temperature be used.

A well-prepared extract should possess in a great degree the odour, and especially the taste, of the plant from which it is obtained; it should not have either an empyreumatic smell or taste, and it should have a proper and uniform consistence. It is necessary to preserve extracts in a dry situation: to assist in keeping watery extracts, it is customary to sprinkle a little alcohol over the surface before covering them up; but watery extracts, if made with cold water and due care, rarely require this precaution. It is proper to examine the condition of all extracts very frequently, both during very warm and very wet weather: any portion which seems spoiled should be immediately thrown out.

Formerly, from the careless or unskilful mode of their preparation, extracts were the most uncertain and useless form of vegetable remedies; but since competent practical and scientific chemists have given their attention to the subject, they are now, in many instances, the most valuable contributions which chemistry has made to practical medicine.

The term is also absurdly applied to a solution of diacetate of lead, called, after its discoverer, *Goulard's Extract*, or *Extract of Saturn*. This is only used externally.

EXTRAORDINARY RAY. When a pencil of light falls upon a doubly refracting crystal, such as one of Iceland spar, it is separated into two rays, one of which is refracted according to the ordinary law, and is termed the *ordinary ray*; the other, according to a new or extraordinary law, and is called the *extraordinary ray*. [Polarisation of Light.]

EXTRAORDINARY REFRACTION. [Mirage.]

EXTRAVASATION (*extra*, without, *vas*, a vessel), in medicine, signifies the escape of any of the fluids from its natural reservoir or canal into some neighbouring cavity or texture. The term is nearly synonymous with effusion, but less comprehensive, as it does not include the case of fluids poured out by secretion, such as dropsies, or any of the products of inflammation. It is most commonly employed in designating effusions of blood or of urine; and we shall therefore confine what we have to say on the subject to a brief notice of the principal varieties of these accidents, referring the reader for more complete information to other parts of the work.

Extravasations of blood are always serious, and often fatal, when the larger vessels and more important organs are concerned in them. Thus if blood escape in consequence of the rupture of an aneurism of the aorta into the bag which encloses the heart, the circulation is immediately arrested, and sudden death ensues. Such an accident is said to be "an extravasation of blood into or within the pericardium." [Aneurism.]

Blood is sometimes driven with great force from a ruptured or wounded artery into the loose spongy substance consisting of connected cells which surrounds and separates the various organs, and is found in great abundance in every part of the body. This is called "extravasation of blood into the cellular tissue" of the part. In such cases, if the vessel be a large one, the extravasation may be so considerable as to occasion enormous swelling and distension of the contiguous parts; and it may be fatal from the amount of the hæmorrhage, or from pressure upon some vital organ, or from mortification. [Hæmorrhage.] This is a frequent source of danger in gunshot wounds. Fractures also are generally followed by considerable effusions of the same kind, which however are soon absorbed, and are not often attended with serious consequences, except in fractures of the skull; in that case they compress the brain, and produce the symptoms of apoplexy. [Head, Injuries of the.] The *thrombus*, or swelling beneath the skin, so frequently observed after bleeding from the arm, is also formed by extravasation of blood into the cellular tissue. It arises from the puncture in the skin not corresponding with the opening in the vein, or not being sufficiently large. It soon disperses, and is of little importance. [Bleeding.] Contusions are likewise followed by extravasation of blood into the cellular tissue under the skin, and in the skin itself, from the rupture of small vessels; and this is the reason of the dark colour assumed by the bruised parts, which often extends to a considerable distance from them, as in the familiar instance of a black eye. This superficial extravasation is generally called *ecchymosis*, a word of the same import.

Spontaneous extravasations of blood, allied to those last mentioned, frequently take place in the progress of various diseases, of which they may be causes or symptoms. The spots which appear under the skin and beneath the membranes which line the internal cavities and tubes, in plague, typhus fever, sea scurvy, and other complaints, are of the symptomatic kind; and these, as well as the discolorations after contusions, are included in the general term *ecchymosis*; they are also known by various other names, as *vibices* (wheals), *petechiæ*, and *purpura*. They are frequently attended with bleeding from the mucous membranes of the intestines and bladder, and of the nose; and they often occur, in the lower extremities especially, when the liver is enlarged, or otherwise diseased. They are supposed in general to indicate a want of tone in the system, and are attributed by some to a *dissolved* and semiputrescent condition of the blood; but they arise in some instances from a plethoric habit, and require bleeding for their cure.

One of the most common causes of apoplexy is an extravasation of blood in the substance of the brain, or between its membranes, from the simultaneous rupture of many minute arteries. It happens for the most part suddenly, when the vessels of the head are preternaturally distended, but yet not without some premonitory signs; and as the affection occurs most frequently at an advanced period of life, when the arterial system in general is disposed to disease, it is probable that the rupture is often preceded by some morbid change which renders the capillary vessels more than usually fragile. [Apoplexy.] The term *apoplexy* has been extended by modern pathologists to similar extravasations occurring in the texture of other organs besides the brain; it may take place in the liver when the venous system of the abdomen is loaded with blood, and from other causes; and it frequently happens in the lungs when their circulation is either obstructed or too forcibly urged in various diseases of the heart. [Heart, Diseases of the.] It likewise happens very commonly in the early stage of consumption, when the body is yet full of blood, and the substance of the lungs is rendered brittle and inelastic by the deposit of tuberculous matter. [Phthisis.] When it occurs in the lungs, the injury is attended with *hæmoptysis*, or spitting of blood. In this, as in many extravasations of the same kind, it is probable that the blood is effused rather in consequence of a *rent*, or breach of continuity in the structure concerned, than from what is implied in the common notion of the breaking of a blood-vessel. But in the early stage of consumption, the blood almost always escapes by *exhalation* from the extremities of the relaxed and distended vessels. See Louis 'On Phthisis Pulmonalis.'

The presence of extravasated blood does not in itself produce much irritation, and the coagulum is soon absorbed when the quantity is not very great, and the vital powers are not depressed by concomitant causes. Where pressure is applicable, the absorption is much quickened by a bandage put on after the immediate effects of the injury have subsided, as in sprains and bruises of the limbs; friction and embrocations have the same effect. See 'An Essay on the Metamorphosis of the Coloured Blood Corpuscles in Extravasated Blood,' by John Burdon Sanderson, M.D., Edinb., 1851.

Extravasations of urine may take place in consequence of rupture of the bladder or urinary passages from ulceration, mechanical injuries, or any cause that produces distension to a great degree. If the fluid escape into the cavity of the abdomen, the result is uniformly and speedily fatal. If it insinuates itself into the cellular tissue in the neighbourhood of the neck of the bladder or the urethra, the accident is still a very serious one, though it generally admits of cure if the nature of it be immediately recognised. The fluid, which is highly deleterious, must be promptly evacuated by free incisions, and care must be taken to prevent further infiltration. If this be neglected, unhealthy suppuration is sure to take place, accompanied by fever of a typhoid character, and followed by extensive mortification.

The most common causes of infiltration of urine are abscesses of the prostate gland, and neglected or mismanaged strictures; and a very frequent consequence is the establishment of a urinary fistula in the perineum. [URINARY ORGANS.]

It may be remarked that the bile is sometimes extravasated in the same way from the gall-ducts or bladder. If it escape into the abdomen, it is followed by a similar fatal result from inflammation of the *peritoneum.* [CALCULI, BILIARY.]

EXTREME AND MEAN RATIO. To cut a line according to extreme and mean ratio, *εὐθεῖαν ἄκρον καὶ μέσον λόγον τεμεῖν*, is a phrase of Euclid which it is not very easy to explain from the words of it. The meaning is, to cut a straight line in such a manner that the whole shall bear to the greater part the same ratio as the greater part to the less; or to make the greater segment a mean proportional between the whole and the less. Accordingly, the square of the greater segment must be equal to the rectangle under the whole and the less segment; and Euclid shows how to make this section in the 11th proposition of the second book.

If the whole line be called unity, and if x be the fraction which is in the greater segment, we must have

$$1-x=x^2, \text{ or } x=\pm\tfrac{1}{2}\sqrt{5}-\tfrac{1}{2}.$$

In the sense of Euclid, only the value $\frac{1}{2}\sqrt{5}-\frac{1}{2}$ will solve the problem; and the other root, with the sign changed, solves the following problem: To produce a line in such manner that the part produced may be a mean proportional between the given line itself and the line made up of the given line and the part produced. Any one who examines Euclid's construction will very easily see the formation of $\frac{1}{2}$, of $\frac{1}{2}\sqrt{5}$, and the subtraction of the first from the second.

The fraction x cannot be expressed arithmetically, and the segments are incommensurable. But if a and b be any two numbers, of which a is the less, and if we form a third by adding the two, a fourth by adding the second and third, and so on, as in the series a, b, $a+b$, $a+2b$, $2a+3b$, $3a+5b$; $5a+8b$, &c., it is demonstrable that the farther we go the more nearly does the ratio of any one to the next represent that of the less to the greater segment of a line divided in extreme and mean ratio. If we begin with 1 and 1, we have the series 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, &c. &c. Thus, if 89 inches be divided into 34 and 55 inches, the division required is nearly made, for the rectangle has 89 × 34, or 3026 square inches, and the square has 55 × 55, or 3025 square inches. This process gives us the results of turning

$$1-x=x^2, \text{ or } x=\frac{1}{1+x}$$

into $x=\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}$, &c. [FRACTIONS, CONTINUED], and then making successive approximations. It is, perhaps, just worth noting, that the nth number in the series 1, 1, 2, 3, 5, 8, &c., is the number of ways in which n can be made up out of odd numbers, differences of order counting as different ways: thus, 6 can be made up in 8 ways out of odd numbers. Accordingly, the greater n is taken, the more nearly are the numbers of ways in which n and $n+1$ can be composed of odd numbers in the proportion of the segments of a line divided in extreme and mean ratio.

The use of this division in elementary geometry is as a step to dividing four right angles into five equal parts, as in the 10th proposition of the fourth book. In fact, the half of $\frac{1}{2}\sqrt{5}-\frac{1}{2}$ is the sine of 18°, the fifth part of a right angle.

EYE, IN OPTICS. [OPTICS.]

EYE-PIECE, a combination of lenses for the purpose of examining the *image* of an object formed by the object-glass, or by an achromatic combination of lenses in the tube of a telescope or of a compound microscope. Eye-pieces are usually of two kinds,—the *Huygenian* or *negative*, and *Ramsden's* or *positive*; but the former is most commonly used. It consists of two plano-convex lenses, with their convex surfaces towards the object-glass. The one nearest the eye is known as the *eye-glass*, while the other is called the *field-glass*, its function being to increase the field of view. Between the two lenses is a perforated *stop* or *diaphragm*, for the purpose of cutting off the extreme rays that might disturb the perfection of the image.

Ramsden's eye-piece also consists of two plano-convex lenses; but the field-glass has its convex surface turned upwards instead of downwards. The positive eye-piece is chiefly used with the micrometer. [MICROSCOPE; TELESCOPE; DOUBLETS; MICROMETER, &c.]

EYES, PROPAGATION BY. The power of propagating plants by any other means than seeds depends entirely on the presence of leaf-buds or "*eyes*," as they are technically called by gardeners. A plant may in fact be regarded as a congeries of individuals, and each leaf-bud is an individual capable of maintaining an independent existence. Though this is generally true, the buds of all plants will not grow when removed from their parent stock. Many, however, admit of their buds being removed from one branch and placed upon another, which constitutes the process of budding. [BUDDING.] Others admit of a branch being removed and placed in the ground, when the leaf-buds upon it will develop, and the wood of the branch form roots. Such branches are called cuttings. [CUTTING.] A few plants admit of single buds being taken and planted in the earth, when they will grow and produce plants in the same manner as seeds. It must, however, be borne in mind in this case that the individual and not the species, as is the case with seeds, is propagated. The plants which are most frequently propagated by eyes are the potato and the vine. It appears that for plants to grow in this manner, the bud requires that a due supply of nutriment should be stored up in the branch or part of the stem to which it is attached. This is undoubtedly the case in the potato, where a large quantity of amylaceous matter is stored up in the tubers, so that a bud cannot be taken without carrying away fragments of its alimentary secretions. Mr. Knight observed, with regard to the buds of the vine, that those grew with most rapidity and strength which were in contact with the largest quantity of alburnum, which he regards as the nutritious matter of the young buds. The provision, however, of alimentary matter may be in some cases, as has been pointed out by Dr. Lindley, disadvantageous by promoting too great a development of stems and leaves. According to theory, the more nutritive matter there is for the eyes, the greater crop there will be; and thus it would seem that it would be more advantageous to plant whole potatoes than portions of the potato or sets. Dr. Lindley proved by a series of numerous experiments, that the weight of potatoes per acre is greater under equal circumstances, from sets than from the whole tubers by upwards of from seven cwt. to three tons per acre, and considerably more on comparison of the clear produce after deducting the weight of sets employed in both cases. He supposes "the rankness of the vegetation from the whole tubers to be the cause of the diminished crop; for the stems were unable to support themselves, and were blown about, laid, and broken by the wind." A curious fact with regard to the growth of the eyes on different parts of the potato has been pointed out in the 'Gardener's Magazine.' It is well known to the cultivators of potatoes in Lancashire that different eyes germinate and yield their produce at very different times, some being ripe or fit for use as early as the middle of May, and others not till June or July. It is found that it is the sets which are nearest the extremity of the potato which ripen soonest; and these are planted in Lancashire in warm places, in March or the beginning of April, and are ready for the market by the middle of May. The produce of the next sets are ready a fortnight after, and that from the root end still later.

In propagating the vine by this means an eye is taken with a small portion of the stem adhering to it, and is placed in earth with a bottom heat of 75° or 80°. It should be kept in a damp atmosphere, when it speedily shoots upwards into a branch, and at the same time establishes itself in the soil by the development of roots. In order to ensure the success of this operation, it is necessary that the bud should be dormant at the time it is removed, and that a small piece of well-ripened wood should be separated with it.

There is another mode of propagating plants resembling this, and that is by planting the abortive branches, called 'Knaurs,' and embryo buds. This plan is pursued in Italy for the propagation of olive trees. These knobs or abortive branches are produced by other trees besides the olive, and might be made use of for the same purpose. The beech, the poplar, the cedar, and many other trees produce these knobs in abundance in this country.

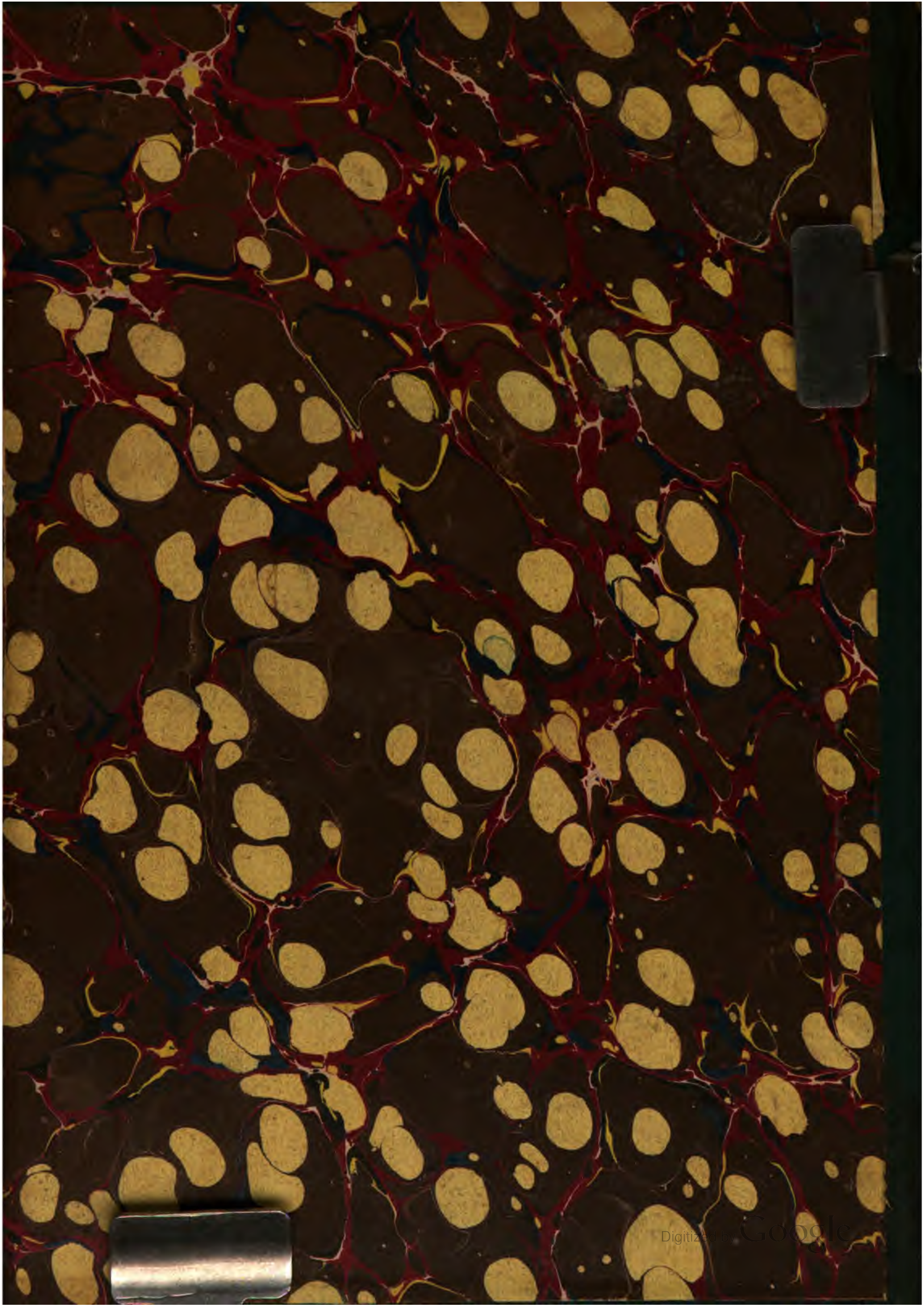
EYRE (from the old French *eyre*, a journey), the court of the justices itinerant who were regularly established, if not first appointed by the parliament of Northampton, A.D. 1176—22 Hen. II.—with a delegated power from the king's great court, or Aula Regis. They were first appointed to make their circuit round the kingdom once in seven years, but by Magna Charta, c. 12, it was provided that they should be sent into every county once a year. (4 Inst. 184.) These itinerant judges have been long superseded by the modern justices of assize. There was also a court so called which was held before the chief justices of the several forests, under the old Forest Laws. [FOREST LAWS.]

END OF VOLUME III.

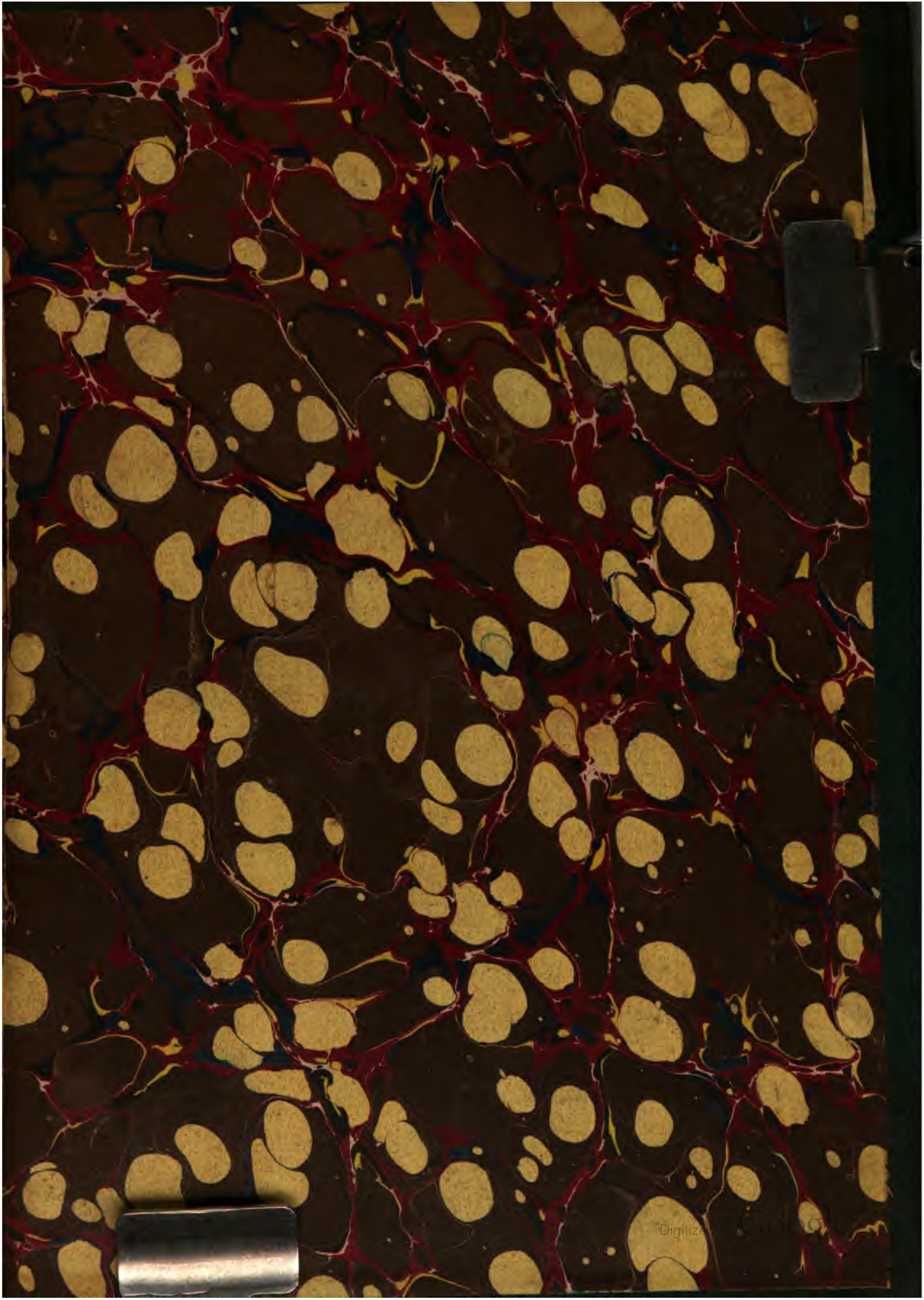
BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.

89094373354

B89094373354A



89094373354
B89094373354A



89094373354
b89094373354a